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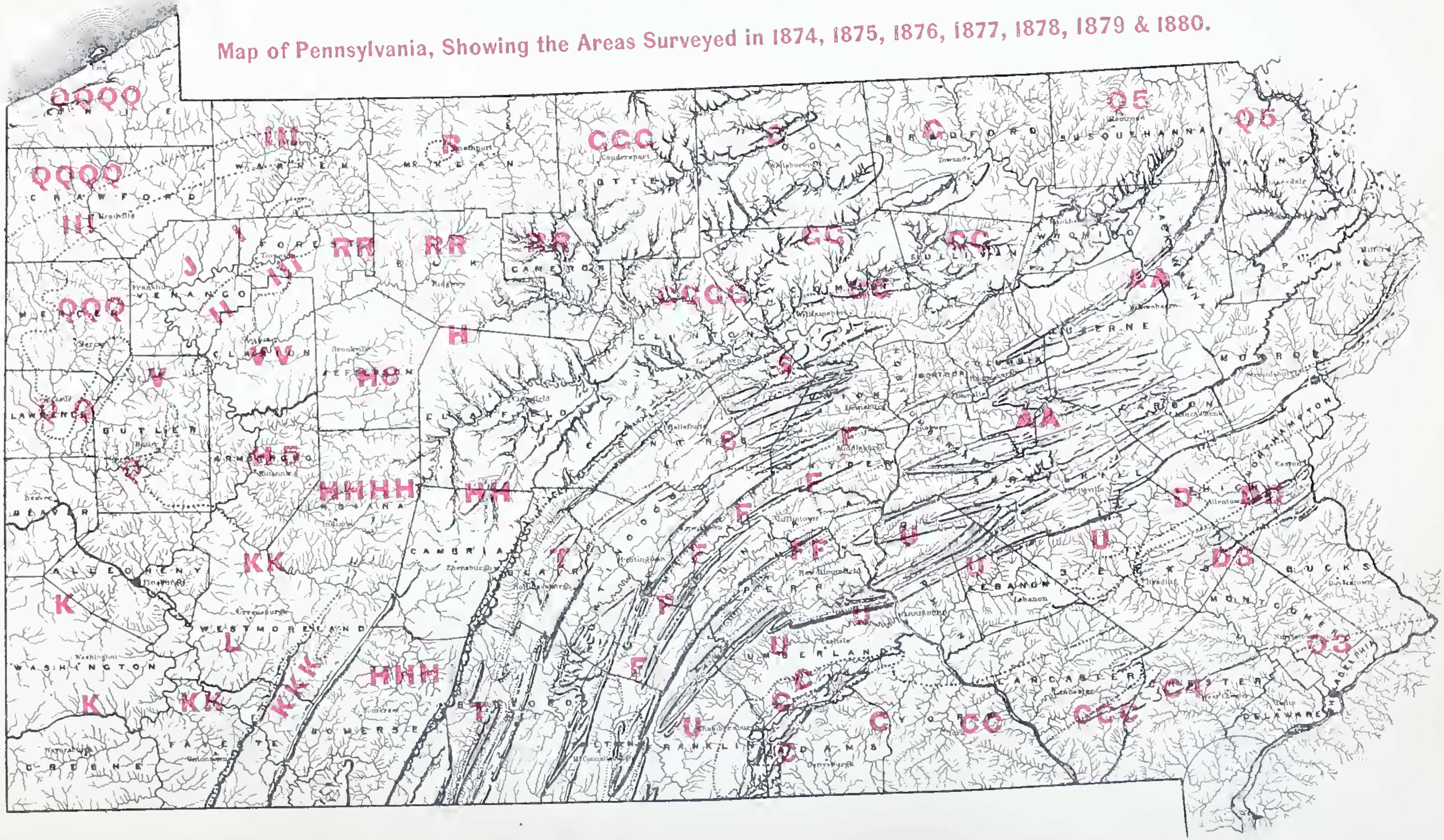

COAL FLORA

OF

PENNSYLVANIA,

BY

LEO LESQUEREUX.

VOLS. I AND II, BOUND TOGETHER.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:
REPORT OF PROGRESS.

P.

DESCRIPTION
OF THE
COAL FLORA
OF
THE CARBONIFEROUS FORMATION
IN
PENNSYLVANIA
AND THROUGHOUT
THE UNITED STATES.

VOL. I.

1. CELLULAR CRYPTOGAMOUS PLANTS, FUNGI, THALASSOPHYTES.
2. VASCULAR CRYPTOGAMOUS PLANTS, CALAMARIÆ, FILICACEÆ (FERNS.)

BY
LEO LESQUEREUX.

HARRISBURG:
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PHILADELPHIA, *February 6, 1880.*

To His Excellency Governor HENRY M. HOYT, *Chairman of the Board of Commissioners of the Second Geological Survey of Pennsylvania* :

SIR: It is with the sincerest satisfaction that I have the honor to transmit Mr. Lesquereux's complete report upon the vegetable remains found in the coal measures of Pennsylvania and other States of the Union.

The scope and thoroughness of this work, representing as it does, investigations uninterruptedly continued through a long life time,—the high authority of its distinguished author among men of science,—the affluence of materials at his disposal,—the enlightened action of the Board permitting these materials to be represented to the eye of the student by so large a number of admirably designed and executed plates—and the hearty interest taken in the proper preparation of the book by many of our fellow citizens who appreciate the progress of human knowledge in every direction—all this has made my official connection with it delightful, and assures me that you will accept and publish it in the conviction that none of your geological reports will prove more satisfactory to the people of the State or reflect more luster on the Survey.

The most remarkable geological report upon the forms of extinct life ever published in America, that of Professor James Hall, of Albany, consists of a series of quarto volumes of text and plates, together or in separate volumes, the last of which have not yet passed through the press. This rich product of the combined industry and genius of one of its citizens has been given to the world at a great expense by the State of New York; but in a form suitable only to use in public and private libraries. It cannot be taken into the field, nor can it find its way into more than a few of the retired spots where local geologists are busy.

The edition is necessarily of moderate size and the volumes are expensive. But it is so great a work, so thorough and accurate, so copious and complete, so systematic and easily referred to, that it has not only made its author famous all over the civilized world, but done much towards placing American science on a par with that of Europe, and the Legislature of New York in the front rank of enlightened governments. No doubt it will be re-cast and published in some manual form for general use and circulation.

What such a manual of molluscan palæontology, descriptive of the forms and habitats of the *shell fish* of early geological times, would be to American field geologists, this work of Mr. Lesquereux is—a manual of the forms and habitats of the *plants* once growing in the swamps of our American coal fields, or floated out into open water and embedded in the deposits at the bottom of the Carboniferous sea.

Every genus of ancient seaweed, fern, bamboo-like Calamite, and cone tree which, up to the present moment, has been brought to light in mining the American coal beds,* or in surveying the surface of the coal fields, is here described, and placed in its natural connection.

Every *species* hitherto discovered is named and described, and as many of them figured as seemed needful to assist the mining geologist in the identification of beds (so far as plant-remains can do that,) or to enlighten the scholar of nature in this branch of learning.

It is more than supposable, indeed, that other *species*, and perhaps other *genera*, remain to be discovered. In fact, every month, thus far, has brought to light some new and interesting variety of form. But the total of the botany of the coal measures may be truly said to have assumed a permanent and (in the main) unchangeable aspect; and this manual, therefore, can justly claim to be not only a reliable but an all sufficient guide to those who wish to understand the subject.

---

* That is, the coal beds of the old coal era. The lignite plants of the Atlantic coast, and the *Cretaceous* and *Tertiary* coal plants of the Mississippi valley, Rocky mountains and Pacific coast, as well as the *Permian* plants of Western Pennsylvania and West Virginia, and the *New Red* plants recently discovered in New Jersey, are not included in this report. It is confined exclusively to the carboniferous and sub-carboniferous plants of the old coal fields. Mr. Lesquereux's elaborately illustrated memoirs on the Cretaceous and Tertiary plants of the Rocky Mountain region, California, and the Mississippi valley, are to be found in the published reports of the United States Surveys of the Territories, &c

The best guarantee for its accuracy is the reputation of its author—a reputation first made more than forty years ago in the peat bogs of Switzerland, and afterwards extended by successive surveys of similar surface deposits in Germany, Scandinavia and Great Britain. Transferring his botanical studies to America in 1848, Mr. Lesquereux accepted service on the First Geological Survey of Pennsylvania in 1851, and made the first report on the coal plants of the State, published as a separate memoir by Prof. H. D. Rogers, in the Geology of Pennsylvania, 1858, vol. II, pages 837 to 884, with 20 quarto plates. In his introduction to it, Prof. Rogers thus writes:

"The following new species of fossil plants, 110 in number, are some of the results of a systematic investigation of the fossil flora of the carboniferous strata of Pennsylvania and the adjacent coal fields of Ohio and Virginia, undertaken a few years ago by my able assistant in this department of the Geological Survey of Pennsylvania, Leo Lesquereux, Esq., formerly of Switzerland, now of Columbus, Ohio.

"By far the greater part of the specimens were collected by himself. A few of the new species were first seen and studied by him in the rich local cabinets of Mr. Clarkson of Carbondale, and of the Rev. W. Moore of Greensburg, to whom our best thanks are due for their liberality in thus opening their collections for the discription of what was new. Many of these hitherto undescribed forms were discovered in the slates associated with the beds of anthracite in the coal fields of eastern Pennsylvania, which compared with the bituminous coal measures of western Pennsylvania, appear not only to contain a greater variety of species, but to present them in a condition of more perfect preservation for study.

"The new species here briefly described by Mr. Lesquereux constitute about one half of the total number of well defined forms hitherto detected by him in the coal measure and lower carboniferous rocks (the Vespertine series) of Pennsylvania ; more than one hundred of the two hundred and twenty species examined by him proving to be entirely identical with species already recognized in the European coal fields." * * * * * *

Between the years 1853, the date of Mr. Lesquereux's report to Professor Rogers, and 1879, the date of the present report to the Board of Commissioners of the Second geological survey of Pennsylvania, Mr. Lesquereux has made elaborate reports to the State geologists of Kentucky, Indiana, Illinois, Arkansas, Mississippi, Alabama and California, and to the United States geologists of the Territories, all of which may be found in the published volumes of their reports, many of them copiously illustrated by plates of figures. A list of these memoirs, those relating to coal plants, will be found in the indexes at the close of this report; and references to them by name and page occur all through it.

The number of his new species, 110 in 1853, has swelled in 26 years to 350 ; and the total number of species described in this report amounts to more than six hundred.

Leaving the author to state in his own excellent way the generalizations, both of a botanical and of a geological kind, at which he has so slowly and laboriously arrived, in the course of the most extensive palæobotanical investigations on both Continents ever made by one individual, I recommend his report to your consideration, and remain, sir,

Your obedient servant,

J. P. LESLEY.

COLUMBUS, OHIO, *January 21, 1880.*

Prof. J. P. LESLEY,
State Geologist of Pennsylvania:

DEAR SIR: My report on the Coal Flora of Pennsylvania and the other United States having been delivered to you some months ago, and the first half of it, as far as to the end of the Ferns, being now printed as a separate volume, I offer, at your suggestion, the following remarks as a short preface to it reserving, the more elaborate Introduction, which I have prepared to the whole work, to be inserted at the close of the descriptions in the second volume.

The want of some convenient book for the study and determination of fossil plants in the Coal measures has always been and still is the chief difficulty which discourages both students and collectors.

True, a great number of works on the subject have been published; but they are all either partial or local in their character. They describe, and illustrate by figures, either some one group of Coal plants, or a number of isolated species, or those of some particular European coal field.

The best and most famous of these works is that of Brongniart, Histoire des Vegétaux Fossiles, published at Paris in the years 1828-1844, and left unfinished at the death of that illustrious botanist.

The student of the vegetation of the Carboniferous age, therefore, can pursue to advantage his researches only after having first procured a series, in fact a whole library, of very costly books; and will sometimes find himself compelled to peruse a number of volumes, in order to arrive at the determination of a single species.

We now have, it is true, the Vegetable Paleontology of Schimper,—an admirable work, the faithful friend and assistant of the phyto-paleontologist. But the use of this book demands an already intimate acquaintance with fossil botany, and therefore cannot be recommended for beginners or collectors. As it describes all the as yet known species, from the earliest (Silurian) to the latest (Pliocene) geological formations, nearly six thousand in number, the descriptions are of course very brief; and as the Atlas which accompanies it consists of only one hundred and ten plates, only such figures are given as serve to illustrate especially the essential characters of the genera.

It is hardly necessary to say that the determination of the vegetable remains of the Coal, in their usual fragmentary condition of Fern-fronds, stems, bark of trees, etc. cannot be made with any degree of accuracy from mere descriptions.

My purpose in preparing this work on the Coal flora of the United States, from materials which I have been procuring and studying for years, has been to make it a kind of manual, to meet the deficiency of books. Thus far, our libraries contain only heterogeneous, partial and local reports on the coal plants of this continent. I wish to offer to amateurs in this field of research the means of conveniently and successfully studying those vegetable remains of a remote age, so widely and abundantly distributed throughout the vast American coal fields, and of late so actively sought after and so carefully collected and preserved by intelligent observers.

This aim has not yet been as fully attained as I could desire; for, a number of the species which I have described in the text are not figured in the Atlas. But it is to be considered that the possible number of plates is indefinitely great. Fossil species, especially those of plants, are generally represented by mere fragments, or accidentally exposed parts, of a whole plant. In some cases the complete elucidation of a single species would require, for itself alone, a number of large plates. The cost of an exhaustive representation may be imagined. It is possible, however, that the Board of Commissioners of the Survey may see fit to authorize a second volume of plates, additional to the Atlas already published.

To compensate for any deficiency of figures as far as possible, I have given in greater detail descriptions, either of different parts of such plants as are only partly figured, or of plants not as yet figured at all. The prolixity of such descriptions is unavoidable.

I have described all the species of vegetable forms known to me as occurring in the coal measures—not only of Pennvania—but of the United States; and I have included among them plants of Carboniferous types discovered in the older or so-called Devonian rocks.

As far as my researches teach me, the Carboniferous measures find their upper limit at one or two hundred feet above the Pittsburg Coal. In the measures lying above this limit another flora has been discovered, of which some of the species have a character representative of Permian types. This flora has been studied by Prof. I. C. White, of West Virginia University at Morgantown, and Prof. W. M. Fontaine, now of the Virginia University at Charlottesville, whose conjoint report upon it is being just published by the Board as Report of Progress PP.

Thus, I trust, the student of fossil botany will find two easily accessible books with which alone he can pursue his researches through the whole Carboniferous system from top to bottom.

My materials have been derived from every available source. I have endeavored to see all accessible localities offering a chance for obtaining specimens. I have examined both private collections and the cabinets of scientific institutions, and have widely offered my assistance in determining specimens for any who were willing to transmit them for that purpose. This has brought to me a mass of materials which I have put to use in notes or figures.

Very valuable assistance has been rendered to my researches by a large number of persons, testifying thus their interest in the preparation of the work. Indeed, I freely acknowledge that it would have been deprived of a considerable part of its importance but for the communication of rare materials furnished by the long, expensive and systematic explorations of Mr. I. F. Mansfield in the roof shales of his Cannelton coal bed; by the immense collection of plant-remains put at my disposal by Mr. R. D. Lacoe of Pittston; and by the generous contributions of Dr. J. H. Britts of Clinton, Mo., and others.

The localities of specimens, and the names of contributors are carefully recorded in the descriptive text; and to all who have helped me in my long researches I hereby send these words of grateful remembrance.

Prof. Louis Agassiz was the first promoter of this Coal Flora of the United States. After his death, the Museum of Comparative Zoology which he founded at Cambridge, Mass. generously allowed me the use of the materials appertaining to the institution, with permission to make them known as opportunities for benefiting science occurred. But without your own interest in the publication of this work it would probably never have seen the light. To Prof. Agassiz and to yourself, my two highly honored friends, therefore, I should dedicate it, were it not the property of the Commonwealth of Pennsylvania.

Very respectfully yours,

L. LESQUEREUX.

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DETERMINATION AND DESCRIPTION
OF THE
VEGETABLE REMAINS
FOUND IN THE
COAL MEASURES OF THE U. S. OF NORTH AMERICA.

CELLULAR ACOTYLEDONOUS PLANTS.

FUNGI.

These plants, generally of a soft cellular tissue, are soon decomposed under atmospheric action. Though extremely numerous at the present time, very few have been found fossil. It is merely from the recent formations, the tertiary especially, that some species have been described. They are mostly referable to *Hypoxileæ*, a class of minute plants, intermediate between the *Fungi* and the *Lychenes* which appear like dots or small black spots, attached to decaying leaves or stems. The characters of these vegetables are derived, in their original state, from minute spores or seeds, inclosed in capsules of diverse forms. They can be studied only with a microscope of a high power, and therefore cannot be positively determined from fossil specimens. Two species of this kind only have been described from the coal measures of Europe: *Excipula Neesii*, Goepp., and *Diplazites Rhabenhorstii*, Gein., both discovered upon the epidermis of pinnules of ferns.

In the North American Coal measures, remains of stems and leaves of large size, like those of the *Cordaites*, are often dotted with small, convex, round or oval protuberences, which, breaking through the tissue and deranging its regular conformation, seem to represent small *Fungi* like species of *Spheria*. It is however extremely hazardous to consider them as organized bodies. For in many cases, these pustular projections are evidently produced by mere physical cause or mechanical agency. In the semi-anthracite coal of Trevorton, for instance, not only the vegetable remains, but the shale, even the coal, are covered and filled with round vesicles, perfectly similar in shape and size to species of *Hypoxileæ*. Some fossil stems and leaves, therefore, seem really to have been inhabited, when living, by groups of *Spheriæ*. But as the same kind of productions are seen upon inorganic matter as well as upon remains of plants, they are evidently the result of a casual interruption in the process of evolution and dispersion of gazeous substances, like the vesicles produced by the action of caloric upon a matter in a state of semi-liquefaction.

In the Geol. of Penna., 1858, p. 847, I have referred to *Polyporites Bowmanni*, Ll. & Hutt., a form which closely resembles the hard mushrooms, *Bolets* or *Polypores*, seen in the woods now, attached to the branches of trees, and characterized by concentric zones of alternate layers of different color. The English specimen on which the fossil species was established has been recognized as a scale of fish. The American one is much larger; the zones less regular; and as no animal remains have been found in the Anthracite measures in connection with it, it cannot be supposed to represent a fish scale. I have seen, of late, in beds of hard ferruginous clay of the Colorado Tertiary, fragments marked with alternate red and yellow bands, regularly placed around a basilar or eccentrical point, presenting an appearance like that of the specimen of the Carboniferous, and seemingly explaining its nature.

The organism described here below is of a far different character, and is to my persuasion the representative of a true *Fungus*.

RHIZOMORPHA, *Roth.*

Fungous filaments of hard substance, disposed in branches abnormally divided and often anastomosing; generally living under the decaying bark of trees.

Until now, these plants have been very rarely found with organs of fructification, and therefore are considered as a kind of *Mycelium*, adventive filaments which represent the first stage of life of the mushrooms.

RHIZOMORPHA SIGILLARIÆ, *Lesqx. Pl. B, Fig. 11.*

Amer. Phil. Soc., Oct. 1877, p. 174.

Stem or principal axis flattened, irregularly round or polygonal in outline, divided all around in branches, either simple or forking, even anastomosing in various directions, inflated upwards, club shaped and obtuse, slightly flattened by compression; surface marked by a netting of narrow wrinkles resembling veins, with intermediate thin veinlets.

The figure exactly represents the specimen. The central or primary axis is quite flat, the branches half round, inflated to the obtuse apex, one to three millimeters broad in the lower part, divided at the base or joined by abnormal anatomosing divisions, often connected in the upper part by thin filaments in right angle, scarcely perceivable without glass. The surface of the flattened axis is smooth, that of the branches wrinkled.

This form, examined by competent mycologists, has been recognized as very closely allied to *Rhizomorpha subcorticalis*, and other species of the present time. Its relation to *Fungineæ* has not been contradicted. Indeed, it cannot be compared to anything else than to a *Rhizomorpha*, except, perhaps, to the borings of some insects into the wood or under the bark. The furrowed passages of insects, however, have by their regularity, especially in the equal dimensions of their tunnels, a far different character. In this specimen the axis is flattened, while the branches are gradually thicker toward the apex, and the filaments derived from the branches are seen penetrating around or on both sides, like very slender threads, scarcely perceivable to the eye. No work of insects can produce such divisions.

For authorities supporting the reference of this vegetable to a *Rhizomorpha*, I mention the names of Dr. Casimir Roumeguère, of Toulouse, France, and of Prof. Chas. H. Peck, of Albany, both celebrated micologists, to whom I owe the communication of numerous specimens for comparison. Prof. Sam'l H. Scudder, of Cambridge, examined the specimen in regard to its possible relation to borings of insects, of which he has made a peculiar study. He considers the characters of the organism as without relation to any kind of animal process. His opinion on this subject is unquestionable.

Habitat—Shale of the Cannelton coal, under the bark of a Sigillaria. The habitat of this organism is an almost positive proof of its relation to *Rhizomorpha*, plants which at the present epoch live under exactly the same circumstances.

Marine Plants, or Thalassophytes.

These plants, generally composed, like the Fungi, of soft cellular tissue, have rarely been preserved in a fossil state. Even at the present time, and though the shallow shores of the sea are inhabited by a luxuriant vegetation of *Fucus*, and covered by heaps of their remains thrown out by the waves; though on some parts of the ocean, and far from any land, the surface of the sea is covered by a vegetation of those marine plants (*Sargassum*), whose branches and filaments are so thickly interwoven, that they sometimes become impassible to ships; though also in the cold regions of both Arctic and Antarctic oceans, species of Algæ are found of immense stature, either of a prodigious length, or of a thickness equaling that of the trunks of large trees,—remains of marine plants are scarcely, if ever, found imbedded, in a state of preservation, either in sand, in clay, or in any other compound, where woody plants generally remain unimpaired and preserved with their normal shape for ages. This difference between the woody, or vascular tissue of the land plants, and the cellular compound of the marine, or fresh water *Algæ*, mere filaments glued together or imbedded in vegetable mucus or gelatine, explains at once not only why the remains of Fucoids are so rarely found petrified, but also why marine plants could not have entered into the formation of the coal for an essential constituent, as some naturalists of old believed it. I have had the opportunity of visiting, in exploring the different phases of the formation of the peat, the shores of the Northern European seas, from Russia to Denmark, Holland and France; and in this country, those of Virginia, North and South Carolina, especially on the borders of the Dismal Swamp; and nowhere have I been able to find any trace of a deposit of seaweeds preserved from decomposition under any kind of superposed materials, sand, clay, etc. And nevertheless, in some of the countries visited, the shores in many localities are strewn with immense heaps of those plants thrown out by the waves. Marine vegetables, though they may appear of hard leathery texture, like some of the most common species of *Fucus*, soon disintegrate, and pass into a gelatinous, half fluid matter, which penetrates the sand, so that the lowest strata of these heaps, when exposed to atmospheric action, do not generally preserve traces of their organism for more than one year.

In the experiments of Lindley, made in studying the comparative duration of the various groups of plants analogous to those which are recognized as entering into the composition of the coal, the author omitted the marine plants, well knowing how soon they are decomposed and destroyed when immersed in fresh water, or under the influence of humidity. It is, as everybody knows, the contrary with the land or woody plants whose tissue is indefinitely preserved by immersion.

Prof. Schimper remarks on this subject, Paleont. Veget., 1, p. 149, that the number of the living Algæ is very great, as seven to eight thousand species have been described; that from the dispersion of the Thalassophytes in the sea now, the banks of *Sargassum* between the Canary Islands and Newfoundland, the floating prairies of Fucoids between Japan and the Kurile Islands, we should suppose that a large number of these plants would be found petrified in the geological strata, but that on the contrary their remains are extremely rare in the marine, and still much more so in the fresh water formations. That only one hundred and eighty fossil species are known until now, while the living species are counted by thousands.

The absence of fossil Thalassophytes is still more marked in the Carboniferous formations than in any other. It is questionable whether any species of true marine *Algæ* had been recognized in these formations before 1866, when I described *Caulerpites marginatus*, Trans. Amer. Philos. Soc. Vol. XIII, p. 313, from remains found in a kind of carboniferous limestone at the horizon of the Millstone grit. This plant, as seen in the description, is closely allied to *Fucoides Cauda-Galli*, a species which had been already traced from the upper strata of the Silurian to the Devonian Chemung, and which Prof. J. Hall supposed as possibly extending its habitat to the lower Carboniferous. I have since that time received from the coal measures specimens of fossil remains positively representing marine organized bodies. The characters of some of them are, however, very peculiar, and as they may be considered as doubtfully ascribable to vegetables, they have been all described here and separately figured in Pl. A and B in order to review the subject with all the materials obtained up to this time. As seen in the references, some have already been published in a Report of the Geological survey of Indiana.

TAONURUS, *Fish. Ost.*

Fucoides, *Vanuxem*. *Taonurus*, *Fish. Ost.*, *1858*. *Spirophyton*, *Hall 1866*. *Physophycus*, *Schp.*, *1869*. *Cancellophycus?* *Sap. in litt. 1879.*

Frond membranaceous, derived from utricules attached to a lateral or central axis, erected or twisted in spiral, flattened in various ways, ribbed; ribs or striæ curved, scythe shaped, converging to the borders, which are either free, naked, or attached on one side or all around to the axis or its branches.

TAONURUS MARGINATUS, *Lesqx., Pl. A, Figs. 1–6.*

Caulerpites marginatus, Lesqx., Trans. Amer. Phil. Soc., Vol. XIII, p. 314, Pl. VII.

Physophicus marginatus, Schp., Paleont. Veget., I, p. 206.

Frond derived from a fucoidal cylindrical axis, branching in its lower part, enlarged upwards to a small utricule which gradually expands into a lyrate lamina, folded in irregular striæ, curving scythe shaped and converging on both sides to the flattened smooth border.

I have examined in place and figured the essential parts of the plant. F. 6 represents, it seems, fucoidal filaments branching and spreading into the mud as radicular appendages. They depend from a simple, tubulous, somewhat broader axis, f. 4, which gradually enlarges into an inflated or flat lamina bordered by two branches of the primary stem. The laminæ, when fully developed, are generally in the form of a lyre, plaited into long nearly parallel wrinkles converging to both borders, narrower, however, and more elongated or decurring on one side than on the other, as in f. 1. Sometimes, as in f. 3 and 5, the axis is not divided or split. It is lateral, merely curved, and bears a narrow lamina, with folds passing from the base of the curve to its top. The appendages, base of f. 1 and 2, are apparently enlarged filaments serving as points of attachment of the fronds to a hard substance, as a kind of hold-fast, such as is seen for the support of species of marine plants whose base is either divided and spreading into soft ground, or flattened and glued upon rocks or hard materials.

Physophicus Andræi, Stur., Culm flora, p. 1, Pl. XXVI, f. 1–5, is distantly related to this species.

Habitat—Ferruginous shale intervening in the horizon of the Millstone grit, on Slippery rock creek, Lawrence County, Pa. The shale is dark gray, the impressions, very distinct under water, become effaced when dry.

TAONURUS COLLETTI, *Lesqx., Pl. A, Fig. 7.*

Chondrites Colletti, Lesqx., Geol. Rept. of Ill., IV, p. 379.

Frond large, narrowed to a basilar support, obovate in outline; lamina cut into laciniæ joined in their length, or *separated, curved up in half circle, converging to the borders.*

This species seems, like the former, to be derived from a cylindrical axis, to which it appears as attached by its narrowed base. The relation of the two parts is not positively ascertained; for though the specimens examined are numerous enough, none of them but this show any connection to a fucoidal filament. The general character however is not dissimilar to that of the former species; only here we have the lamina totally separated from the frame formed around the fronds by the fucoidal filaments, in f. 1 and 2, of the same plate. The base of f. 1 shows a mode of attachment very much like that of f. 7. The shape of the frond is also very similar. The wrinkles of the surface are more distinct in this species, often cut through and separated as laciniæ. Other specimens show the divisions still more clearly, and the laciniæ sub-cylindrical. The size of the fronds is very variable and their outlines also. Some of them half round, or even disciform, are intermediate between the former species and *T. Cauda-Galli.*

Spirophyton typum, Hall, (16th Ann. Rep. of the Nat. Hist. of New York, p. 80, with woodcut,) is, at least, as far as seen from the figures, closely allied to this species, if not identical with it. It differs by the laciniæ more indistinctly interwoven, not parallel, not separated.

Habitat—Towle's mill, five miles east of Lodi, Fountain Co., Inda., horizon of Coal No. 5, of the Illinois section. Communicated by Mr. John Collett. The specimen figured was received from Dr. J. H. Britts, and obtained in Missouri, near the base of the coal measures of that State.

TAONURUS CAUDA-GALLI, (*Fisch. Ost.*,) *Vanux.*

Fucoides Cauda-Galli, Vanux., Geol. Rept. Third District of New York, p. 128 and wood cuts.

General form of the frond, circular, but with the outlines rarely defined; ridges or laciniæ curving from the center all around, more abruptly bent to the margin, like the feather of a cock's tail.

The species is distinct from the former ones by the circular form of the frond, and the disposition of the laciniæ around a central point. Its size is very large, some of the fronds measuring one foot. It is locally extremely common, as for example at the base of the Millstone grit, along the western borders of the coal measures of East Kentucky, where I have seen large surfaces of Sandstone entirely covered with its remains.

All the forms of *Taonurus*, considered as specifically different, may perhaps be modifications or varieties of one. They are rarely found in a good state of preservation, and are difficult to study. F. 1–6, of Pl. A, indicate the mode of development of these plants, as from a vesicular production or inflation of the top of the cylindrical axis, the membrane plaited or lacerated filling the space between the separate and distended borders, which are either persistent and distinct, or gradually merged into the laminæ. Prof. J. Hall considers their growth as an unfolding of the axis in a spiral progression, hence the generic name of *Spirophyton*, proposed by him for these plants.

PALÆOPHYCUS, *Hall.*

Frond expanding by dichotomous, repeated sub-divisions, from a radical simple axis; branches cylindrical or slightly flattened, obtuse, sometimes umbonate, either simple or anastomosing by divisions in right angle; surface smooth or dotted.

This genus has been established by Hall, in Paleont. of New York, vol. I, p. 1. Its definition is here somewhat modified, according to the characters of the species which I refer to it. It is the equivalent, in name at least, of the old genus *Fucoides* of Brongniart, which, used as it was originally for the description of marine plants of different characters, even of *Grap tolithes*, had become too indefinite for classification. Schimper, narrowing its limits, has preserved it for species of the type of *Fucoides antiquus*, Brgt., (*Bythotrephis antiquata*, Hall), and of *Palæophycus*. The last name proposed before the modification of the genus *Fucoides*, should be preserved for the American species of marine plants answering to the characters fixed by Hall. They are of a type widely represented in the old formations of this continent, and rarely recognized in Europe until now

PALÆOPHYCUS MILLERI, *Lesqx., Pl. A, Figs. 8–8b.*

Geol. Rept. of Ind., 1875, p. 136, Pl. I, f. 1–3.

Frond large; branches either erect or expanding around a central axis, forking in acute angle of divergence, or anastomosing between them, cylindrical or slightly flattened, generally thicker towards the obtuse apex, sometimes umbonate, cut across or strangled by deep lines at right angles to the axis; surface smooth or punctate.

Even on the same specimen, the characters of this plant are extremely variable, as seen f. 8, which represents it with a number of its peculiar modifications. The ramification is dichotomous, or irregularly anastomosing. Genally the branches become thicker towards the obtuse apex, but they are also regularly cylindrical and of equal size in their whole length, or here and there bossed, or abruptly cut and prolifer, bearing at their intersections small branches implanted upon stumps, a kind of sub-division analogous to that of the living *Caulerpa prolifera*, Lamour., of Florida. The surface, also, though generally punctate, and marked here and there with prominent papillæ regularly placed in spiral, (f. 8 and 8*b*, enlarged), is smooth in some parts of the branches, as if the dots had been here and there partially erased by the action of the waves. Some of the branches of the specimens of Mr. Miller are much larger than those figured, varying from four to fifteen millimeters in thickness.

The species is distantly related to *P. tubularis*, Hall, Paleont. of New York, v. I, p. 7, Pl. II, f. 1, 2, especially like an undescribed fragment figured in the same vol., Pl. XXI, f. 3, from the Calciferous sandstone.

Habitat—Concretions of Carbonate of Iron in a bed of clay over Coal L of the Ind. Geol. Reports, Vigo County.

Communicated by Prof. E. T. Cox and Mr. J. F. Miller, of Richmont, Ind.

PALÆOPHYCUS GRACILIS, *Lesqx.*, *Pl. B*, *Figs. 9–10a.*

Geol. Rept. of Ind., 1875, *p.* 137, *Pl. I*, *f.* 4–5*b*.

Frond small, enlarging upwards by repeated dichotomy; branches cylindrical, forking in a more or less open angle of divergence, slender, gradually decreasing in thickness from the base up to an obtuse point, easily split horizontally, sometimes slightly punctate, generally smooth.

The whole frond as represented f. 9, is a little more than three centimeters long, and nearly as broad in its upper part. The thickness of the main stem, as far down as it can be seen, is two millimeters, decreasing upwards to the obtuse apex of the cylindrical branches, scarcely half a millimeter thick.

This species is evidently of the same type as the former, essentially differing by the small size of all its parts. Even its surface is also sometimes dotted or rough, though generally smooth. These two forms bear to each other the same relation that *Chondrites antiquus St.*, has to *Buthotrephis gracilis*, Hall, which Goeppert considers as varieties of the same species. Without taking into account the great difference in the size, and the form of the branches of the plants figured, the first by Goeppert, Uebergsg., Pl. I, f. 1, the second by Hall, l. c., Pl. XXI, f. 1, it is certainly hazardous to unite in one species fragments of marine plants of Europe and of the United States, from some likeness remarked in the figures. *Buthotrephis antiquata*, Hall, l. c., Pl. II, f. 6, and *B. gracilis*, Hall, appear to be the same species, but different from the European *Chondrites antiquus*. Though it may be, the plants described here as *Palæophycus*, are clearly distinct from any of those named above.

Habitat—With the former, and communicated by Prof. E. T. Cox.

PALÆOPHYCUS DIVARICATUS. *Lesqx.*

Geol. Rept. of Ind., 1875, *p.* 138.

Frond flattened into creeping branches diverging around the central axis; branches cylindrical, or more or less *flattened by compression, irregularly forking and anastomosing by cross divisions, nearly equal in size in their whole length, obtuse, surface smooth.*

The species differs from *P. Milleri* by the more slender branches, generally simple or united by anastomosis or divisions by branchlets at right angles. The surface is quite smooth and the facies different, somewhat like *Phytopsis cellulosum*, Hall, Paleont. of New York, I, p. 39, Pl. IX, f. 1 to 1*d*, which, according to Emmons, represent a polyp. Our plant is smaller in all its parts, of an amorphous compound, evidently of the same generic division as both of the former species. I should even have considered it a variety of *P. Milleri*, but for the difference in the mode of its divisions, and for its smooth surface.

Habitat with the former. I have seen one specimen only, from the cabinet of Mr. I. F. Miller.

ASTEROPHYCUS, *Lesqx.*

Stem short, cylindrical; frond expanded and divided star-like from the top of the central axis; segments flattened or inflated.

ASTEROPHYCUS COXII, *Lesqx., Pl. B, Figs. 5, 6.*

Geol. Rept. of Ind., 1875, p. 139, Pl. II.

Divisions of the fronds flattened, large, oblong, obtuse or obcordate; surface deeply and irregularly wrinkled lengthwise.

The figures represent the specimen in half its size, and merely half of its surface, for it bears five of those star like vegetable remains, placed in rows, three on one side, two on the other. The largest is twelve centimeters in diameter between the ends of the opposite divisions, the smallest only six centimeters, and the divisions are in all radiating in five or six, from the central axis. Sometimes they appear doubled, or superposed, as independent of each other, and separately growing from the center, above those of which the lower surface only is seen, the lower divisions being joined near their base, those above apparently separated in the whole length. The younger blades or shoots are somewhat cylindrical and scarcely striate, rather transversely rugose, narrowed to the point of attachment, as seen, f. 5. A specimen communicated by Rev. H. Herzer, bears a longer fragment of the axis, to the base of which are attached numerous cylindrical short branches, one to two centimeters thick, spindle shaped, evidently basilar supports of the plant, serving as lateral holdfasts, same as seen at the base of some *Algæ* of the present time. Another specimen has the surface strewn with longer cylindrical basilar filaments, similar to rootlets or fastening ligaments, also like those of living marine plants, which, when of large size, have both the filaments like roots, and above them appendages which help to the support of the plants.

Habitat—Hard sandstone or quartzite, connected with the coal beds of the cut off of the Wabash, near New Harmony, Ind., Upper Coal measures, E. T. Cox. Sandstone bed of the Lower Coal measures, near Rock Castle, Ky., Rev. H. Herzer.

ASTEROPHYCUS SIMPLEX, *Sp. nov.*, *Pl. B*, *Figs. 7, 8.*

Frond composed of cylindrical spindle-shaped branches, placed star-like around a central axis, free to the base.

I have represented only a fragment of a larger specimen, which bears a number of fronds diversely placed upon the surface of the stone, or without any regular disposition in regard to each other. They are not all as symmetrical as those of the fragments figured, or at least their regularity is impaired by the imbedding of some of the rays. These branches, about eight in number, two and a half to four centimeters long, five to seven millimeters in diameter in the upper enlarged part, are exactly spindle shaped, gradually enlarging from a narrow base to above the middle. and thence more rapidly narrowed to a blunt point. The central axis is circular and varies in size in proportion to the rays which join it without connection of their borders. The surface is smooth or irregularly dotted. The shale is strewn with cylindrical flexuous creeping branches, apparently related to the fronds, either as support or as connecting filaments between them. Indeed the star-like, so called fronds, appear as scattered upon heaps of radicular filaments mixed in every direction, very numerous, often filling the clay, without any of the regularly conformed bodies. The generic affinity of the plant with the former is evident.

Habitat—Ferruginous clay near Beaver, Penna., above the Millstone grit. Discovered by Prof. I. C. White. The specimens figured have been kindly communicated by Mr. Jos. Hartman, of Pittsburg, Pa.

CONOSTYCHUS, *Lesqx.*

Stipe cylindrical, continuous; frond enlarging from the base upwards in the shape of a plate or of a cup, or increasing by successive superposed layers or concentrical laminæ; top cup-shaped, concave.

For the diagnosis of this genus, in Geol. Rept. of Ind., 1875, p. 142, I had a single specimen, Pl. B, f. 4, and from its peculiar shape and the abrasion of the borders of the laminæ in the enlarged border, I hypothetically considered this border as the lower part of the frond and figured it upside down. A number of other specimens, f. 1 and 3, prove the error of this supposition. These organized bodies, whose reference to plants is questionable, have in their mode of growth a relation to some marine *Algæ* of our time, the *Acetabulariæ*, which bear, on a continuous stipe, successive umbrella shaped fronds, the lower rendered solid by incrustation of calcareous matter. In the fossil species described here the fronds appear thick, all of the same hard compact substance. But for this character also, we have a point of comparison in species of *Zonaria*, whose fronds are composed of divers branches enlarging fan-like in half circular blades, cut on the borders in parallel oblong laciniæ, the whole plant being of a hard, opaque, thick substance.

These organisms, however, might be considered as sponges; for the fossils described here find a degree of analogy in some species of the order of the *Hexactinellidæ*, Smith, e. g. for the cup shaped form, *Capellia rugosa*, Goldf., and *Camerospongia fungiformis*, Goldf.; and for fronds enlarged umbrella-like, flat on the top and undulate crenate on the reflexed borders, in *Coeloptychium agaricoides*, Gold.* But none of the sponges have a continuous axis, and even in a fossil state, their surface is always rugose.

In comparing, the figures in the two plates A and B, the characters of all the species which they represent, denote in all an evident analogy of development which does not leave any doubt of their relation to the same class of natural productions. The cylindrical branches of Pl. A, f. 8, are reproduced in the stipes of f. 4; and its top expansion explains the mode of division of the cylindrical filaments which bear the starlike fronds, f. 7 and 8, Pl. B. The generic relation of this last plant with *Asterophycus Coxii*, Pl. B, f. 5 and 6, is clear enough. Both differ from sponges by their characters, and therefore—as we see in f. 1 and 3 the same mode of development as in f. 5 and 6, excepting only the mode of division of the fronds, lobate in these last, entire in the others—we have to refer the whole either to sponges or to vegetables. The first alternative has for it a less degree of evidence than the second. The only objection against the reference of these bodies to vegetables is in the thickness and compactedness of the fronds. But, as seen above, there is an analogy of composition in the *Acetabulariæ*,—which have the outer frond thickened by incrustations of calcareous matter in such a way that these plants have often been considered as corals, while the upper divisions are soft, and also in the hard compact texture of the *Zonariæ*.

CONOSTICHUS BROADHEADI, *Sp. nov., Pl. B, Figs. 1 and 2.*

Stipe short, cylindrical, transversely ribbed; frond semiglobular, cup shaped, concave inside, distinctly three costate and deeply wrinkled lengthwise on the outside; substance thick.

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*Handbuch of Palæontologie by W. P. Schimper and Karl A. Zittel, 2d lief., 1879.—A work of which only two parts are published as yet.

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I owe the communication of this beautiful specimen to Prof. G. C. Broadhead. It has been very exactly represented, both for the inside and the outside characters. It is a little more than eight centimeters across at its top, and five centimeters up from the apex of the stipe to the borders, which average one centimeter in thickness. They appear composed of superposed layers of amorphous stony matter. The outside, exactly cup shaped, has three equidistant, strong ribs, more than one centimeter high and as broad at the enlarging base, with large wrinkles disposed lengthwise, and regular rugose branchlets, which seem as sculptured by hand, for the outside ornamentation of the cup. The inside concavity is irregularly rough, about two centimeters deep at the flat bottom, covered by a layer of inorganic matter.

Habitat—Shale near the base of the coal measures, Vernon County, Mo., about half way between Nevada and Fort Scott; Prof. G. C. Broadhead.

CONOSTICHUS PROLIFER, *Sp. nov., Pl. B, Fig. 3.*

Frond thick, disciform, disposed in successive series upon a continuous, narrow, cylindrical stipe.

The disks, somewhat cup-shaped, abruptly curving on the outside of the axis, with a nearly flat base, concave inside, are grown superposed to each other, attached to a stipe whose remnant is seen in the center of the disks. These are easily separable by the breaking of the axis, smooth, both inside and outside, only irregularly wrinkled at the borders, five to six centimeters across, the upper ones gradually smaller.

I have seen a few specimens of this species, two only in a good state of preservation, both with three superposed plates separating by the breaking of the axis, the upper plate bearing, like the lower ones, a fragment of the stipe in its center, showing its size and form and indicating a further continuation of the process of development.

Habitat—The specimen figured has been communicated by Prof. G. C. Broadhead, from the same locality as the former; others, from Kentucky, were found by Rev. H. Herzer, with fragments of *Asterophycus Coxii.*

CONOSTICHUS ORNATUS, *Lesqx.*, *Pl. B*, *Fig. 4.*

Geol. Rept. of Ind., 1875, p. 142, Pl. I, f. 6.

Frond obconical, composed of superposed layers gradually increasing in size from the base upwards, and regularly lobate on the borders by deep lines, diverging star like from the axis, and passing up to the top.

The mode of development of this plant, in accordance with that of the two former species, is from a cylindrical basilar axis, by successive layers or laminæ formed around it in continuous superposition. These laminæ are regularly cut on the borders by deep lines, which pass like rays from the central axis to the borders of the lobes, being on the same plan or opposite. The broken part near the base shows that these laminæ or successive fronds were not agglutinated, but free and superposed to each other like those of the former species, merely differing by the greater proximity of quite flat plates of equal thickness. These plates are not so thick as in the former species, as probably their close superposition prevented the incrustation of foreign matter. The star-like divisions marked upon the broken surface are in correspondence with those of *Asterophycus.*

Some remains, showing affinity to those described above, are figured by Hall, Paleont. of New York, vol. II, Pl. X, f. 9 *a*, *b*, 10. The author considers them as roots of *Bythotrephis.*

Habitat—Sandstone of the Coal Measures, between Coal 1 and 2 of the Geol. Section of Illinois, Mr. I. H. Southwell.

VASCULAR CRYPTOGAMOUS PLANTS, OR ACROGENS.

CALAMARIÆ.

Plants herbaceous or arborescent; stems fistulose, articulate, traversed at the articulations by a solid wall (diaphragm), marked on the outside face of the bark by longitudinal parallel narrow ribs and furrows; leaves *verticillate, free in their whole length or confluent at base, linear-lanceolate or subspatulate or wedge form, simple, nerved or plurinerved; branches from the axils of the leaves, verticillate.*

To this order, represented in the vegetation of this epoch by the *Equisetaceæ* (Horse-tail family), I refer the genera *Bornia*, *Calamodendron*, *Asterophyllites*, *Annularia*, *Sphenophyllum*, *Calamostachys*, *Macrostachya*, *Equisetites* and *Trochophyllum?*

The plants of this order are very common in the Carboniferous measures, often found imbedded in sandstone, but more generally in the coal, where they constitute by their remains distinct layers of combustible matter, sometimes of remarkable thickness. As represented in the North American Coal Measures, their characters are taken merely from the inside and outside impressions of the bark, and from the branches, leaves and organs of fructification, transformed into coal, or preserved upon the stony matter imbedding their remains.

A marked difference seems to exist in the structure of the trunks, and in the character of the texture; some authors, who have been able to study it from silicified specimens, have separated these plants into two groups, one referred to the *Equisetaceæ*, the other the dicotyledonous gymnosperms, under the names of *Calamitea* and *Calamodendron*. The evidence on the subject is not yet sufficient for definitive conclusions, and, deprived of the means of pursuing anatomical researches of that kind, for until now we have had no silicified specimens of any remains of these plants in the North American Coal measures, I follow here the distribution admitted by Schimper, referring to *Calamariæ* all the coal plants whose characters recognized from the outside of the remains, agree with the above description.

The students who wish to become acquainted with the views of the Phytopaleontologists upon the difficult subject of the internal structure of the *Calamites*, will find abundant materials exposed and discussed in the works of Petzhold, Cotta, Brongniart, (who in his Tableau des Genres reverses a former opinion expressed in the Histoire des Vegetaux fossils,) Unger, Goeppert, Ettingshausen, especially in the English authors Binney and Williamson, (who are contradicted by Dawson, of Montreal,) and more recently in Weiss, Grand 'Eury and Stur. The whole matter is reviewed by Schimper in a clear and very interesting resumé, Paleont. veget. I, p. 291–312.

CALAMITES, *Suck.*

Plants arborescent; trunks cylindrical, articulate; articulations variable in distance, rapidly closer towards the narrowed obconical base; surface narrowly ribbed and furrowed lengthwise; ribs equal, simple, parallel, contracted or rounded at the articulations; branches nearly at right angles, verticillate like the leaves, which are lanceolate acuminate, simple nerved.

The Calamites are rarely found with branches attached to the trunks, and still more rarely with leaves attached to the branches. I have never seen in the American Coal Measures branches bearing leaves in connection with a trunk of *Calamites* except of one species.

Schimper has described most of the species of *Asterophyllites* under the generic name of *Calamocladus*, which represents their derivation from *Calamites* as branches. This relation is generally admitted, but I think that the branches with leaves, found attached to trunks, have to be described in their totality as *Calamites;* all the others whose relation to trunks is not positively known find their place in the old genus *Asterophyllites.*

The species of *Calamites* are vaguely defined in their characters. Those who have on hand only a few specimens recognize easily marked differences and may therefore indefinitely multiply the species. But after a prolonged comparison of a large number of fragments of these plants, the points of differences, appreciable at first, become blended or gradually pass into each other in such a way that some authors, like Ettinghausen, have merged all the forms into a simple original type, recognizing one species only. If, as it seems proved, *Asterophyllites* are branches of *Cala-*

mites, as these branches have positively characters distinct enough to force their distribution into a number of species, the trunks cannot represent a single type with mere varieties. Therefore variations, though obscurely distinguishable upon the bark of the trunks, have to be considered as specific. This is the opinion of the generality of Phytopaleontologists and my experience forces me to admit it as really authorized.

Roots of *Calamites* are as rarely found attached to the stems as are the branches. Grand 'Eury in his Flore Carbonifère, a splendid work recently published, represents the base of stems as obconical, gradually pointed, sometimes curved, even horizontal, short pointed at both ends, and thus subterranean with close articulation, bearing, instead of leaves, bundles of narrow flat rootlets diverging around at right angles. It seems therefore that the lower part of the stems represent a kind of rhizoma, as the articulations sometimes bear instead of radicles small obconical branches really bases of stems of the same plants. One of the figures however represents a linear narrowly ribbed and articulate rhizoma, emitting at the articulation either radicles or obconical fragments of stem. I have seen on ferruginous nodules of Mazon Creek fragments of linear, leaf-like appendages which seem to belong to *Calamites* as roots. I have also described with *C. Cannæformis* scars of rootlets, but have never found any kind of organs referable to roots attached to stems of *Calamites*, not even on the basilar fragments of these plants, seen standing in groups or as a forest imbedded into sandstone at Carbondale. Grand 'Eury observes that these vegetable organs are easily destroyed, soon disappear, and that more generally the base of the trunk is naked.

CALAMITES SUCKOWII, *Brgt., Pl. I, Figs. 3, 4.*

Calamites Suckowii, Brgt., Hist. d. veg. foss., p. 124, Pl. XV, f. 1–6; XVI, f. 2–4. Gein. Verst., p. 6, Pl. XIII, f. 1–6. Weiss, Foss. flo., p. 117, Pl. XIII, f. 5. Heer Fl. fos. Hebr., IV, p. 46. Lesqx., Geol. of Penna., 1858, p. 850; Geol. Rept. of Ills., II, p. 445. Schp. Paleont. Veget., I, p. 312, Pl. XVIII, f. 1.

C. nodosus, Brgt., l. c., p. 133, Pl. XXIII, f. 3.

C. communis, Ett. Beitr. in Natur. Abh. von W. Haidinger, IV, 1, p. 73.

Stem generally broader than the space between the articulations (internodes); ribs half round or planoconvex, obtuse at the articulations; furrows narrow, obtusely carinate; tubercles (impressions of leaves) more or less distinct, oval.

The stems average seven to twelve centimeters in thickness when not flattened. The epidermis is very thin, smooth and the bark also thin, the ribs distinct, the articulations somewhat variable, close toward the base. When decorticated, the under surface, distinctly ribbed, is narrowly striate lengthwise, more obscurely so on the outside surface.

This most common species of our coal measures is generally represented in flattened fragments in the shale overlaying the coal, but always in cylindrical sections of stems in the sandstone. Near Carbondale, Pa., there is a standing forest of *Calamites*, stems or trunks, buried in a bed of hard sandstone twenty feet thick or more. From an inclined tunnel cut through this sandstone to the coal below, such a mass of fragments of stems have been taken out that a long viaduct has been constructed of them. All the fragments represent the same species; all have their original cylindrical shape preserved, but many are folded or plaited on the surface in various directions, as are generally the hollow stems like those of reeds by the compression of an outside force.

The tubercles are mostly oval, but also sometimes round, half globular, smooth, placed at the top of the ribs, rarely at their base.

Habitat—All the strata of the middle coal measures from the conglomerate to the Pittsburg Coal, or in the Anthracite from the Mammoth Vein to the Salem Vein.

CALAMITES MAJOR, *Weiss.*

Foss. fl., p. 119, Pl. XIII, f. 6; Pl. XIV, f. 1.

Stem large; internodes short; ribs broader, somewhat angular or obtuse in joining the articulations; scars large oval; cortex thicker.

Weiss has separated this species as intermediate between *C. Suckowii* and *C. gigas*, I think, with good reason. The specimen which I refer to this and which had been left as uncertainly referable to one of these two species, is a large stem, twenty-four centimeters broad, flattened to a thickness of five centimeters; the articulations are only four to four and a half centimeters distant; the ribs nearly three millimeters wide, convex, with concave furrows, and the coaly bark nearly twice as thick as in the generality of the specimens of *C. Suckowii*. The characters are definite and evidently different from both the related congeners, and the specimen preserved in concretions is very distinct.

Habitat—Mazon Creek concretions.

CALAMITES RAMOSUS, *Artis, Pl. I, Fig. 2.*

Artis, Antedel. Phytol., Pl. II. Brgt., Hist. d. veg. foss., p. 127, Pl. XVII, f. 5, 6. Gutb., Abdr., p. 18, Pl. II, f. 6. Gr. d'Eury, Fl. carb, p. 20, Pl. II, f. 4. Lesqx., Geol. of Penna., 1858, p. 850; Geol. Rept. of Ills., II, p. 445.

C. Suckowii, Schp., Paleont. veget., I, p. 312.

Stem branching; articulations distant; ribs flat; furrows narrow; tubercles oval, often undefined at both ends of the ribs; scars of branches large, round.

This species is evidently distinct from *C. Suckowii* by the distant articulations, the branches attached to the middle of the articulations, covering them with their large scars extending equally both ways, above and below. The branches are large, comparatively to the stems, as seen from the specimen figured, which measures nine centimeters in diameter (flattened) and the branch nearly three centimeters. Another specimen from Cannelton, twenty-eight centimeters long, four and a half centimeters broad (flattened), has five articulations, the basilar ones four and a half centimeters distant, the upper ones seven to eight, with flat, distinct ribs, rather continuous than alternating, more or less inflated at the articulations, or with indistinct undefined tubercles and branch scars large and round. Still another specimen from the same locality, forty-three centimeters long, seven centimeters broad (flattened), has only three articulations, sixteen to eighteen centimeters distant, one of them with a branch somewhat oblique, ten centimeters long, one and a half centimeters broad at the narrowed base, without any articulation. All the specimens I have seen of this species present the same characters. Per contra, from the immense number of fragments of *C. Suckowii*, mentioned above as seen at Carbondale, I have not found a single one marked with scars of a branch and none with long internodes.

Habitat—It is not as common as *C. Suckowii*, though distributed also over the whole thickness of the middle coal measures, Gate Vein, near Pottsville, Murphysborough and Duquoin, Ills., Cannelton, Pa., in fine specimens.

CALAMITES RAMIFER, Stur.

Culm Flora, p. 82, Pl. III, f. 3, 3b, 4. Pl. IV, f. 2, 3, 4; f. 18, p. 26.

Stem small; bark thin; articulations and furrows scarcely marked upon the bark, distinct on the dicorticated surface; furrows close, narrow, flat, some converging, others continuous; ribs very narrow; tubercles scarcely distinct; branches narrowed to the base; articulations distant.

This description of the author concords in most of its points with the characters of a conglomerate species, of which a large number of fragments have been obtained at Pittston, Pa. The main stem about ten centimeters broad, with distant articulations, is marked on the cortex with flat, scarcely distinct furrows, and very narrow ribs, the whole surface being very thinly lineate. The tubercles are indistinct or none. The primary branches, nearly two centimeters broad (flattened), have articulations twelve centimeters distant, the secondary branches five millimeters broad have them six centimeters distant, and bear whorls of leaves and branchlets of a third order, with gradually shorter sub-divisions and shorter leaves. The leaves are flat, lanceolate-acuminate, slightly narrowed from the middle to the point of attachment, comparatively long, two centimeters in the lowest whorls, with a broad, rarely distinguishable medial nerve. By their size and shape these leaves are remarkably similar to those of *Asterophyllites foliosus*, as figured by Gein. Verst., Pl. XVI, f. 2. But in this last species the articulations are close, and as seen f. 1, the branches are rapidly decreasing in size upwards. In the sub-conglomerate species, the branches are long and cylindrical. If, as indicated by Schimper, *Asterophyllites foliosus*, of Ll. & Hutt., and of Gein., is referable to *Calamites Suckowii*, our American species has nothing comparable to it except the leaves. It could be more easily confounded with *C. ramosus*, but is evidently different by its narrow furrows, only one millimeter broad, while in a stem of the same diameter those of the former species are three millimeters wide; by the absence of tubercles, and especially by the contraction of the ribs, three, more generally four, towards deep round points, scars of small adventive buds, placed on the articulations, sometimes very close to each other. On one of my specimens, these bud scars are only four to five millimeters distant, and thus all the ribs, without exception, are converging in fascicles of three to six to these scars. The contraction of the ribs is perfectly distinct under the thin bark. but obscure upon its smooth surface. Remarkably enough, the larger scars of developed branches change the direction of the ribs in an opposite way, the middle ones being abruptly cut by the borders of the branches, while the lateral, forced outside, turn around the scar or are continuous. A disposition of the same kind, but far less regular, is often remarked on specimens of *C. approximatus*, as figured by Gein. Verst., Pl. XI, f. 2 and 5; Pl. XII, f. 1–2; also by Schimper, atlas, Pl. XIX, f. 1, etc. This however is a species far different by its close articulations, broader ribs, and generally distinct tubercles.

Habitat—Sub-conglomerate shale, Campbell's ledge, near Pittston. Specimens in the cabinet of Mr. R. D. Lacoe. The last specimen described, with ribs converging to the articulations, is from Cannelton, communicated by Mr. I. F. Mansfield.

CALAMITES CANNÆFORMIS, *Schloth., Pl. 1, Fig. 1.*

Schloth., Petrf., p. 398, Pl. XX, f. 1. Brgt. Hist. d. Veg. foss., p. 131, Pl. XXI. Gein. Verst., p. 5, Pl. XIII, f. 8; Pl. XIV, f. 1, 2, 4. Gr. d' Ey., Fl. Carb., p. 21, Pl. III, f. 1–2. Lesqx., Geol. of Penna., 1858, p. 850. Schimp. Paleont. veget. I, p. 316, Pl. XX, f. 1–3.

C. decoratus, Brgt., l. c., p. 123, Pl. XIV, f. 1–5. Artis, Antedil. Phytol., Pl. XXIV.

C. suckowii, Heer, Fl. foss. Helv., IV, p. 46.

Stem large; articulations variable in distance; furrows broad, obtuse, sometimes marked in the middle by a sharp thin line; ribs convex, wedge-form, and alternately joined at the articulations; scars of leaves distinct, obsolete or absent.

The species is much like *C. Suckowii*, and separated from it by rather indefinite characters. The ribs are larger, more distinctly convex, wedge form, and alternately connivent at the articulations; the furrows broader, more obtusely carinate. The ribs are generally broader, more flattened toward the obconical base of the stems, sometimes bearing distinct round tubercles, a form which has been separated by Brongniart as *C. decoratus*. The ribs of this species are sometimes as large as those of *C. Gigas*, as seen by the fragments figured by Schimper l. c., and by Geinitz l. c., Pl. XIV, f. 2. One of my specimens, from Mazon creek, the basilar part of a flattened stem, nine centimeters in diameter, has the ribs five millimeters broad. The specimen bears round or oval scars, irregularly placed over the whole stem, five millimeters in diameter, evidently scars of roots, marked by central punctiform, convex, broad papillæ, like the vascular scars of *Stigmaria*. This form is transient to *C. gigas*, and as far as I can see, separated from it merely by the smaller size of the stems, and its habitat in the true coal measures. It seems to represent the fragment described by Goepp., as *C. variolatus*, Fl. d. Uebergsg., p. 124, Pl. V. It is the only specimen I have seen of this character.

Habitat—It has the same distribution as *C. Suckowii*, but is more rarely found.

CALAMITES GIGAS, *Brgt.*

Hist. d. veg. foss., p. 136, Pl. XXVII. Weiss, Foss. fl., p. 117, Pl. XIII, f. 8; Pl. XIV, f. 2. Schp., Paleont. veget., 1, p. 319, Pl. XX, f. 2, 4.

Stem very thick; *ribs six to eight millimeters wide, convex, without tubercles, wedge-form, and alternate at the articulations.*

I have a mere fragment, showing by its outside curve to be part of a trunk thirty or thirty-five centimeters in diameter, with convex ribs seven millimeters broad, and sharp narrow furrows. From the presence of this specimen, I consider the locality where it was found as Permian or permo-carboniferous.

Habitat—Rocky Mountains in Sandstone with *C. Cistii*, and the trunks remarked upon in the description of *Calamodendron.* Communicated by the U. S. Geol. Survey of the Territories, under the direction of Dr. F. V. Hayden.

Calamites approximatus, *Schloth.—Pl. I, Fig. 5.*

C. approximatus (et interruptus?) Schloth., Petref., p. 399, 400, Pl. XX, f. 2. Artis. Antedel. Phytol., Pl. IV. Ll. &. Hutt., Foss. fl., I, Pl. LXXVII; III, Pl. CCXVI. Brgt. Hist. d. veg. foss., p. 133, Pl. XV, f. 7, 8; Pl. XXIV. Gein., Verst., p. 7, Pl. XI, f. 1–5; Pl. XII, f. 1–3. Heer. Fl., foss. Helv., IV., p. 46, Pl. XX, f. 5. Lesqx. Geol. of Penna., 1858, p. 850; Geol. Rept. of Ill., II, p. 445. Schp., Paleont. Veget., I, p. 314, Pl. XVIII, f. 2; Pl. XIX.

C. eruciatus, elongatus, alternans, difformis, Petzholdi, leiodermus, Gutb.

C. varians, St. Germ. Weiss.

C. eommunis, Ett., ex parte, etc.

Stems very variable in size; cortex comparatively thick; articulations somewhat contracted, close, especially towards the base; ribs indistinct on the bark, clearly marked on the impressions of the underside, convex, with deep furrows, two or three sometimes converging at their base on the articulations.

This species is the most common and the most variable of all. The distance between the articulations is never as long as the width of the stems; it varies between one centimeter and three. When flattened, the stems are often split lengthwise as in f. 5. Therefore they seem to have been hollow cylinders without woody axis, like *C. Suckowii.*

There is, however, as yet a great deal of uncertainty about the true characters of this species. *C. cruciatus*, Brgt., generally considered by European authors as a variety of *C. approximatus*, differs especially by the convergence of some of the ribs to the round points, placed upon the articulations, as described above from a specimen referred to *C. ramifer*. This variety is very common. Geinitz, l. c., represents it especially. The figures of Schimper's Atlas of the Paleont. veget., l. c., represents also a specimen with this character. Grand'Eury, Fl. Carb., p. 294, considering this *Calamite* as the bark of a *Calamodendron*, refer it to the Cotyledonous. As seen from the section of a trunk, Pl. XXX, f. 7, of his work, this bark is the outer layer of a concentric series of thick woody zones. In the large number of Carboniferous specimens which I have examined of this so-called variety of *C. approximatus*, I have been able to see only a comparatively thin bark, and under it, the striæ representing the impression of the under surface resting upon clay or inorganic matter, without traces of woody fibers underneath, or any coaly matter representing them.

Habatat—It is found in its numerous varieties in all the strata of the middle coal measures.

CALAMITES CISTII, *Brgt.—Pl. I, Fig. 6.*

Brgt. Hist. d. veg. foss., p. 129, Pl. XX. Gein., Verst., p. 7, Pl. XII, f. 4, 5; Pl. XIII, f. 7. Heer, Fl. foss. Helv., IV, p. 47, Pl. XX, f. 3. Grd.'E., Fl. Carb., p. 19, Pl. II, f. 1, 3. Lesqx., Geol. of Penna., 1858, p. 850; Geol. Rept. of Ill., II, p. 445. Schp., Paleont. Veget., I, p. 313.
C. varians, Weiss, Foss. fl., p. 114.

Articulations about equally distant except toward the base; ribs narrow, half round, with obtuse striate furrows; tubercles generally absent or small, round, indistinct.

This species is easily recognized by its regular narrow ribs, either convex or half round, the length of the internodes greater than in *C. Suckowii*, and the general absence of leaf tubercles. The stems are generally of small size, at least, never as large as the distance between the articulations.

Habitat—Not rare in the middle Coal measures; especially common in the anthracite basin of Penna.; Carbondale, Pittston and Wilkesbarre. I have seen one specimen only from the concretions of Mazon Creek.

CALAMITES DUBIUS, *Artis.*

Antedel. Phytol., Pl. XIII. Brgt., Hist. d. veg. foss., p. 130, Pl. XVIII, f. 1-3. Lesqx., Geol. of Penna., 1858, p. 850. Schp., Paleont. Veget., 1, p. 313.
C. bistriatus? Lesqx., l. c., p. 850, Pl. II, f. 1.

Articulations distant; ribs narrow, of the same character as those of the former; furrows more distinctly striate; tubercles mostly obsolete.

This species is very much like the former. It essentially differs by larger stems and longer internodes, sometimes thirty to fifty centimeters long. Therefore, fragments of this species, one foot long or more, are sometimes found without articulations. The lines or striæ of the surface are more distinct than on any other species of *Calamites*. The ribs average one millimeter in width; rarely, and only when flattened, two millimeters.

The fragment figured as *C. bistriatus*, Lesqx., l. c., may be referable to this species. The ribs are however twice as broad, the furrows very narrow, rather acutely carinate than obtuse. It might be compared to *C. Suckowii*, but for the absence of tubercles, the distinctly striate surface both upon and under the bark, and the contraction of the articulations. As I have not seen any other fragment similarly related than the one figured, the species is left uncertain.

Habitat—Same as the former. Mr. R. D. Lacoe has many very large specimens of both these two last species in his cabinet. The first are from E vein (Butler v.) of Pittston; those referable to this species come from Oliphant No. 1 vein.

CALAMITES PACHYDERMA, *Brgt.*

Hist. d. veg. foss., p. 132, Pl. XXII.

Stem large; bark thick; articulations distant; ribs scarcely marked on the outer surface, but distinct under the bark, flat, unequal, often converging; tubercles obsolete.

This species is not mentioned by any other of the European authors, except Grand' Eury, who places it among the doubtful species. He has, however, seen standing *Calamites*, with the characters described by Brongniart. I cannot say anything more positive on the subject. I have found in the conglomerate sandstone of Caseyville, Ky., large pieces of bark, twenty to thirty centimeters broad, five to eight millimeters thick, with the under surface distinctly and unequally ribbed, and traces of distant articulations. There is also, in the State cabinet of Illinois, a fragment answering exactly to Brongniart's description, with the same characters, thickness of the bark especially, as the specimens from Caseyville, and the under surface more distinctly ribbed. These are the only fragments which I have considered as referable to the species. Like most of the vegetable remains imbedded in Conglomerate Sandstone, they are badly preserved, and the characters always more or less uncertain.

Habitat—Conglomerate measures, Caseyville, Ky.

Calamites of uncertain relation.

CALAMITES DISJUNCTUS, *Lesqx.*

Geol. of Penna., 1858, p. 850, Pl. II, f. 5.

Stem small; articulations comparatively distant, thick, marked in the lower part by an inflated ring; surface punctate and dotted.

I have seen only as comparable to the fragment described, a specimen from Cannelton, which probably represents the same species. The articulations are at equal distances, a little more than two centimeters, marked just underneath or in the middle, by a distinct elevated ring, which cuts the ribs square, without deranging their direction exactly, as in *Bornia radiata.* The ribs are quite flat, striate, but rendered somewhat obscure by a corrugation of the surface, comparable to the dotting upon the first specimen described under this name.

Habitat—Cannelton, Pa., I. F. Mansfield. The specimen described in Geol. of Penna., l. c., was found at the Gate Vein, near Pottsville.

CALAMITES GRACILIS. *Sp. nov., Pl. LXXV, f. 17.*

Branch narrow; articulations close, strangled; ribs flat; furrows marked by a mere line; cortex comparatively thick.

This branch, originally more than twenty centimeters long, is only five millimeters broad, with articulations two centimeters distant, narrowed or strangled. The flat ribs are marked merely by thin lines representing the furrows. No branches of *Calamites* or of any species of this section are to my knowledge comparable to this. The pieces of bark surrounding the articulations, seem like remains of sheaths, and give to this fragment the aspect of a stem of *Equisetum*. But the pellicle of bark, thick, at least comparatively to the size of the stem, is merely irregularly lacerated, as by erosion, and does not show the border teeth of a sheath. I found this specimen in a bed of black ferruginous limestone, with impressions of marine invertebrates, and a few decomposed and indistinct vegetable fragments. The coaly bark and the striæ are characters which prevent its reference to marine plants.

Habitat—Upper Coal strata, Western Kentucky.

BORNIA, *Roem.*

Stems cylindrical, articulate and furrowed as in Calamites; articulations scarcely contracted; ribs cut square or obtuse at the articulations, continuous, not alterning, thinly striate; cortical cylinder thick; leaves verticillate, free, linear-lanceolate.

BORNIA RADIATA, (*Brgt.,*) *Schp.—Pl. I, Fig. 7.*

Bornia transitionis, F. A. Roem., Paleont., III, Pl. VII, f. 8. Grd.'E., Fl. carb., p. 54.

Calamites radiatus, Brgt., Hist. d. Veg. foss., p. 122, Pl. XXVI, f. 1, 2. Heer, Foss. Fl. der., Bären Insel, p. 32, Pl. I–VI.

C. transitionis, Goepp., Foss., Fl. d. Uebergsg., p. 116, Pl. III, IV, XXXVIII. Daws., Dev. Pl., Quat. Journ. Geol. Soc., Nov., 1862, p. 309.

C. variolatus, Goepp.. l. c., p. 124, Pl. V.

C. obliquus, Goepp., l. c., p. 121, Pl. VI, f. 9, 10.

C. undulatus, Lesqx., Geol. Rept. of Arks., II, p. 312, Pl. IV, f. 7, 7a.

C. inornatus, Daws., l. c., p. 310.

Noeggerathia crassa, Goepp., l. c., p. 220, Pl. XL.

Bornia radiata, Schp., Paleont. veget., I, p. 335; III, p. 454, Pl. XXIV, f. 1–10.

Archaeocalamites radiatus, Stur. Culm Flora, p. 74. Pl. II, f. 1–6; III, f. 1, 2; IV, V, f. 1.

The character of the species is that of the genus.

The stems, as far as I have seen them on numerous specimens from the sub-conglomerate Carboniferous of Alabama are small, five to eight centimeters in diameter; the ribs and furrows, one to three millimeters broad, are effaced on the surface, very distinct on the decorticated cylinder, and distinctly striate lengthwise. The articulations are generally very narrow, as cutting across the ribs, which are thus continuous, parallel and without deviations. In some rare cases, however, the articulations are slightly contracted. Heer, l. c., has given a very detailed description of the species, with six plates of remarkably fine illustrations, and critically examined all the forms described by other authors which he refers to this species. No mention is made of the internal structures of these plants. Roemer only says that the internal cylinder is surrounded by a zone of cellular matter, and Stur describes the stem as formed of a central cylinder, placed at a distance of the epidermis.

Mr. R. D. Lacoe has in his cabinet a beautiful specimen of this species, obtained from the sub-conglomerate shale of Campbell's ledge, near Pittston. It is a branch, fourteen centimeters long, five millimeters broad, with articulations two and a half centimeters distant, surrounded by whorls of thirty to forty linear, canaliculate leaves, less than one millimeter broad, six and a half centimeters long, straight up or very oblique, some of them curved inward. This branch is of the same character as the fragment represented in Schimper's Atlas, l. c., Pl. XXIV, f. 2. The leaves seem to be joined at the base two together; at least they are approximate by two at the base.

Habitat—Common in the sub-conglomerate measures of Alabama; communicated by Mr. J. H. Aldrick. Found also near Pittston, by Mr. R. D. Lacoe. The specimen described by Prof. Dawson, as *C. transitionis*, is from the Hamilton Group; that of *C. inornatus*, from the Genessee slate, both of New York State.

CALAMODENDRON, *Brgt.*

Central cylinder striate lengthwise and articulate, surrounded by a thick woody cylinder, or bark, with outside surface smooth.

It is on the anatomical structure of this outside zone, especially, that the discussion bears concerning the reference of these plants to cryptogamous, or to cotyledonous gymnospermous plants.

CALAMODENDRON ? SPECIES, *Pl. LXXV, Fig. 16.*

Internal ribbed cylinder small, variable in size; articulations deep but narrow, irregular in distance; ribs flat, cut square at the base, and continuous; furrows distinct, but very narrow; bark thick, smooth.

The whole specimen, eight and a half centimeters long, is figured. The internal cylinder has the characters of *Calamites approximatus*, differing merely by variation of its size, being inflated in the middle to sixteen millimeters in width, while a little above, its breadth is decreased to one centimeter. The articulations are also more variable in length than in any of the specimens of *C. approximatus* which I have seen. They are marked by distinct points, apparently the bases of bundles of vessels. The bark, transformed into hard cannel coal, averages six millimeters in thickness, and is not enlarged in accordance with the variation in size of the internal cylinder, so that its borders are nearly parallel. This queer conformation is not peculiar to this single specimen, for I find it still more evident in some large fragments which may represent a different species, and which have been recently received from the Rocky Mountains.

The largest of these fragments, thirteen centimeters in diameter, is exactly cylindrical, marked on its outside by articulations, regularly distant, two and a half centimeters, much inflated, with half-round projections at different distances, corresponding in character and position to the small round scars seen upon f. 16. The surface is regularly ribbed, the ribs flat or slightly convex, the furrows sharply carinate, but very narrow. The whole is a compound of coarse sandstone, and except the outside marks, no trace of central or internal axis is seen. On other specimens the central axis is partly covered by the bark, or by an outer-layer of tissue, variable in thickness, five to twenty millimeters, measured at different parts of the same line of circumference. The outer surface is also marked transversely by prominent rings corresponding to the articulations of the internal cylinder, and vertically by longitudinal ribs which, though broader, seem to correspond to those of the central axis. In all the fragments, all the ribs, either of the surface or of the internal cylinder, are equal in width in their whole length, without trace of convergence at the articulations. One of them is remarkable for this fact: the internal cylinder is broadly channeled, half hollowed in the middle, as by a flexure, and the outer zone is in places much thicker, as if it had filled the depression under it, measuring on one side of the fragment only one to two millimeters in thickness, while it is twenty-two on the other. That this variation is not caused by compression, is seen by the horizontal inflated rings and the regular ribs of the surface, which preserve the same direction and relative distance. There are, however, other specimens evidently curved, with the concave side without bark, and the convex one more or less thickly covered with it. Others of these trunks vary in diameter from three to twelve centimeters. In some of them the ribs of the surface tend in opposite directions or zigzags, from every successive articulation, at an angle of about 140°.

In comparing these fragments to the beautiful figures representing restored stems of *Arthropitus* and *Calamodendron*, in Grd.'E., Pl. XXX, f. 7 and 8, it is evident that the large specimens from the Rocky Mountains are referable to one of these genera—probably to *Arthropitus*, while the specimen of Pl. LXXV, f. 16, may represent *Calamodendron approximatum*, Cotta, which Goeppert mentions in Perm. Fl., p. 180, as synonymous with *Calamites approximatus*. The stem of this species, as figured by Dawson, Quat. Journ. Geol. Soc., May, 1866, is small, only two and one half centimeters, and has the articulations at irregular distances, like the fragment f. 16, of our plate.

I have, however, also from Cannelton, another specimen, whose character seems to contradict this reference. It is a stem of the same size as the one figured, also flexuous or variable in thickness, twenty-two millimeters in the middle, where it is more inflated, contracted only a little lower to eleven millimeters, with the articulations close—five to eight millimeters distant. On the inflated part of the stem, the articulations bear large oval scars, six millimeters long, five millimeters broad, four millimeters distant, transversely, alternating with others of the same character, placed higher up at intervals of three short internodes. The close articulations, the ribs and the scars, are like what we should expect to see on branches of a *Macrostachya*, representing, in a reduced scale, the upper part of Atl., Pl. III, f. 14.

Habitat—The specimen figured is from Cannelton, found by Mr. I. F. Mansfield, as all the specimens mentioned from this locality. The other large ones were sent from Colorado, with *Calamites gigas*, by the collectors of the U. S. Geological Surveys under the direction of Dr. F. V. Hayden.

ASTEROPHYLLITES, *Brgt.* CALAMOCLADUS, *Schp.*

Stems articulate; branches opposite; central axis hollow or solid; leaves verticillate, free to the base, linear, acuminate, simple nerved. Fructifications in elongated ears bearing round sporanges in the axils of the leaves.

Brongniart, Grand'Eury, and some other authors, consider either all the *Asterophyllites*, or some species of the genus, as referable to the Phænogamous Gymnosperms, as branches of *Calamodendron*. I do not know as yet any species with characters different from those of the *Calamariæ*. Some of them represent, evidently, branches of *Calamites*, and have been described by Schimper as *Calamocladus*. Paleont. Vegt. 1 p. 423.

ASTEROPHYLLITES EQUISETIFORMIS, *Schloth.—Pl. II, Fig. 3, 3a, Pl. III, Figs. 5–7.*

Casuarinites equisetiformis, Schloth., Flor. d. Vorw., Pl. I, f. 1; II, f. 3.

Asterophyllites equisetiformis, Brgt., Prodr., p. 159. Roehl, Paleont., XVIII, p. 22, Pl. III, f. 5. Gein. Verst., p. 8, Pl. XVII, f. 1–3. Germ., Verst., p. 21, Pl. VIII. Goepp., Perm. Fl., p. 36, Pl. 1, f. 5. Lesqx. Geol. of Penn'a, 1858, p. 851. Geol. Rept. of Ill., II, p. 444.

A. ovalis, ? Lesqx., Geol. of Penn'a, 1858, p. 851, Pl. I, f. 2.

A. erectifolius, Andrews, Geol. Rept. of Ohio, Paleont., II, p. 425, Pl. XLIX, f. 3.

Hypurites longifolius, Ll. & Hutt., Foss. fl. Pl. CXCI.

Calamocladus equisetiformis, Schp., Paleont. Veget., 1, p. 324. Pl. XXII, f. 1, 2, 3. Crepin, Bull. Acad. Belg., XXXVIII, Nov., 1874, p. 7.

Primary branches long, obscurely striate; cortex thick; lateral branches more or less oblique, simple; leaves linear, acuminate, straight or curved inside; costa thick.

It is one of the most common species of the genus, and being of hard texture, is generally found in well preserved specimens. The best I have seen is a branch eighty-eight centimeters long, the stem one and a half centimeters broad at the base, gradually narrowed to two millimeters near the top, (broken.) The lateral branches, ten centimeters long at the base, also become gradually shorter upward, to five centimeters. The leaves, one to one and a half centimeters at the base, half as long at the apex of the branches, are a little more than one millimeter broad. The articulations upon the main stem are surrounded by a vertical column of leaves appressed against the stem like sheaths; but on fragmentary specimens, these leaves are mostly destroyed, or sometimes open. The number of leaves, seen on different specimens, varies from ten to twenty in each whorl. They can, however, rarely be all counted, being often destroyed in part, or imbedded in the stone. The width also varies from one half to one millimeter, and the length sometimes reaches to fifteen, even seventeen millimeters. The stems are generally deprived of the bark. The articulations are neither enlarged nor contracted, merely slightly inflated a little above and below the point of insertion of the leaves. In young branches the articulations are very close and the leaves crowded in spikes.

According to Dr. Feistmantel, Flor. d. Bohm. Steinkohl, p. 117, Pl. X, f. 3, the fructifications are in long spiciform branches, with short internodes, bearing leaves like those of the branches of *Asterophyllites*, with sporanges placed in the axils of the leaves. The description and figure agree with the fragment, described Geol. of Penn'a, 1858, p. 851, Pl. I, f. 2, as *A. ovalis*. These fructifications are very rare. They are comparable to those of Atl., Pl. III, f. 5–7. The branches are, however, narrower on the specimens figured here. It may be referable to another species.

Habitat—The whole extent of the coal measures; more prominent in the upper strata. The fine specimens mentioned above are from Cannelton, Pa. In the Anthracite, it is most common at the Gate Vein, near Pottsville.

ASTEROPHYLLITES ANTHRACINUS, *Heer.*

Fl. foss. Helv., IV, p. 50, Pl. XVIII, f. 2, 3.

Articulations very close; leaves much longer than the internodes, imbricate, curved inward, linear, slightly narrower at the base; medial nerve obsolete.

This form, as described by the author, appears to be a good species. At least I have seen a number of specimens which represent it, especially in the more compact, thicker leaves, without trace of medial nerve. The articulations are three and a half to four millimeters distant in the whole length of the branches, the leaves at least twice as long as the articulations, are slightly narrower at the base. There is an unimportant difference from the European form, in the direction of the leaves, which are straight up, not generally curved inward. But even some of the figures of the author represent them in that way.

Habitat—Cannelton, Pa., Mr. I. F. Mansfield; more rarely found than the former. The museum of Princeton College has splendid specimens of this species, from the same locality.

ASTEROPHYLLITES LONGIFOLIUS, *Brgt.* (*Prodr.*)

Ll. & Hutt., Foss. fl., Pl. XVIII. Gein., Verst., p. 9, Pl. XVIII, f. 2, 3. Heer., Fl. foss., Helv., IV, p. 50, Pl. XIX, f. 3.

Calamites tenuifolius, Ett., Steink. v. Stradonitz, p. 5, Pl. VI, f. 5; Steink. v. Radnitz, p. 27, Pl. II, f. 1-3; Pl. III, f. 4.

Calamocladus longifolius, Schp., Paleont. Veget., I, p. 323.

Branch generally small, with distant articulations, distinctly striate; leaves numerous, very long, open, linear, subulate, flat, flexuous.

The leaves vary from three to ten centimeters long, averaging seven to eight. They are very narrow, scarcely one millimeter broad, flat, rather flexuous than rigid; medial nerve distinct.

The synonimy of this species is not quite clear. *Asterophyllites tenuifolius*, St., II, Pl. XIX, f. 1, 2, referred to this species by Schimper, rather resembles *A. rigidus*, as well as *Bruckmania longifolia*, St., II, Pl. LVIII, f. 1. *Asterophyllites comosus* and *Jubatus*, Ll. & Hutt., Foss. fl., Pl. CVIII, and CXXXIII, seem by their crowded leaves and broad stem to represent a different species.

Habitat—More rarely found than the following, which it resembles. Wilkesbarre, Pittston, Pa., from the subconglomerate Campbell's ledge; Morris, Ill., in many specimens.

ASTEROPHYLLITES RIGIDUS, *Gein.*

Verst., p. 9, Pl. XVII, f. 7-8. Brgt. Prodr., p. 159. Ll. & Hutt., Fos. fl., Pl. CCXI. Lesqx., Geol. Rept. of Ill., IV, p. 424, Pl. XXI, f. 4, 4b.

Calamocladus rigidus, Schp., Paleont. Veget., I, p. 324.

Branches somewhat thicker; articulations shorter; surface indistinctly or very narrowly striate; leaves rigid, deeply concave or half cylindrical; nerve thick.

These characters are seen from good specimens preserved in the nodules of Mazon Creek, as the essential differences which separate the species from *A. longifolius*, to which it is closely allied. The leaves are of about the same length. One specimen from Mazon Creek, has them ten centimeters long, another only four and a half.

Habitat—Nodules of Mazon Creek; Cannelton; Pittston, Brown Colliery, E., as seen in the cabinet of Mr. R. D. Lacoe.

ASTEROPHYLLITES SUBLÆVIS, *Lesqx.*

Geol. of Penn'a., 1858, p. 851, Pl. I, f. 3.

Branches thick; articulations close, equidistant; surface of the stem smooth, merely undulate lengthwise below the inflated articulations; leaves short, linear, gradually acuminate; branches short, with two to four whorls of short leaves.

This species is easily known, by its comparatively broad (five to ten millimeters), smooth stems; the short internodes, thirteen to fifteen millimeters; the short leaves, half as long as the internodes, flat, half open, gradually narrowed from the base to the acumen; and the short branches generally placed on the same side of the stem, none longer than the internodes, oblique, with two or three whorls of short open leaves. I have many specimens of this plant from the same locality, but no *Calamites*, which by concordance of characters, could be supposed to be its trunk.

Habitat—Shale of the Anthracite of Rhode Island—Mount Hope Coal; Mr. James H. Clark. Also found at Cannelton, one specimen only.

ASTEROPHYLLITES FOLIOSUS, *Ll. & Hutt.*

Foss. fl., Pl. XXV, f. 1. Gein. Verst., p. 10, Pl. XV and XVI. Lesqx., Geol. of Penn'a., 1858, p. 851. Geol. Rept. of Ill., IV, p. 424.

Hydatica prostrata, H. columnaris, Myriophyllum gracile, Artis, Anted. Phytol., Pl. I, 5, 12 (roots and rootlets).

Wolkmannia disticha, St., Vers., 1, p. 30, Pl. XLVIII, f. 3 (spikes).

Bechera dubia, St., ibid., p. 30, Pl. LI, f. 3 (branches and leaves).

Asterophyllites lanceolatus, Lesqx., Geol. of Penn'a., 1858, p. 852 (spike).

Calamocladus foliosus, Schp., Paleont. Veget., I, p. 326.

Annularia longifolia? Lesqx., Geol. Rept. of Ill., IV, p. 422, Pl. XXI, f. 1, 2.

Branches slender, narrowly striate; leaves shorter than the articulations, verticillate, eight or ten in a whorl, distinct at the base, linear-lanceolate, obscurely nerved; fructifications in spikes with close articulations and long lanceolate imbricating leaves or scales.

The specimens which I refer to this species, all in nodules from Mazon Creek, exhibit the following characters: A long root, one centimeter thick, articulate at great distances, with the surface obscurely striate, marked by deep points in irregular positions, evidently scars of rootlets. The radicles from the articulations are flat, two millimeters broad, also distantly articulate, with branches in whorls, half a millimeter broad, short or very long and flexuous. The whole surface of the specimen is covered by these rootlets, derived either from the articulations or from different parts of the stem and of the branches, as marked by the dots of their scars. With this, we have other specimens representing leaves and stems. One has a branch attached to the articulations of a large-ribbed stem of *Calamites*, two and one half centimeters broad, with flat or slightly convex ribs two millimeters broad, furrows sharp but very narrow, answering to the characters of *Calamites ramosus* by the ribs and the position of the derived branches. These have the articulations close and the leaves imbricated in tufts as in Gein., l. c., Pl. XVI, f. 1. They are certainly not spikes but branches bearing leaves of *Calamites*. These leaves in their crowded state are rarely distinct, but can be seen sometimes separate. They have the same characters as the leaves f. 2, of the same plate, in Gein., l. c. They are twelve to fifteen millimeters long, two millimeters broad in the middle, lanceolate, sharply acuminate, with a thick medial nerve three fourths of a millimeter broad. The identity of these fragments with those figured by the German author is positive, and I consider as referable to the same species the fragments described Geol. Rept. of Ill., IV, f. 1 and 2, as *Annularia longifolia*.

Now, with this I have a fertile specimen, a fragment also, with a deeply-ribbed axis, three millimeters broad, with short, inflated articulations, five millimeters distant, and leaves of just the same width and length as those of the species, with a very broad nerve, bearing oval sporanges at the articulations.

This may represent the fruiting branch of this plant for all the fertile spikes of *Asterophyllites* show, as far as they are known, bracts of the same character as the leaves of the species to which they belong.

I have indeed many fragments comparable to those figured by Sternb., Pl. XLVIII, f. 3a 3b, as *Wolkmannia disticha*, positively spikes, or ears, and not agglomerations of leaves crowded and imbricated at the top of the branches, as in Geinitz's figure. The pedicels of these ears one centimeter broad, are closely articulate, the inflated articulations being only three to four millimeters distant, with linear-lanceolate, distinctly and sharply nerved leaves, seven millimeters long, or twice as long as the internodes, and therefore imbricated. They are abruptly constricted at the top to five millimeters, half their size, and bear long ears, nearly two centimeters thick, with close articulations, surrounded by long lanceolate leaves, larger than those of the stem, and also twice as long as the internodes. The spikes have the characters of the cones of *Macrostachya*. Their reference to the species is not certain. They are described in Geol. of Penn'a., l. c., as *Asterophyllites lanceolatus*.

Grand 'Eury, in his Flor. Carb., p. 31, has represented in wood cuts, branches which he considers as probably referable to *A. foliosus*, a species, which he says, may perhaps represent *Calamites Cistii*. I have from Cannelton a fragment of a branch, which in its characters is perfectly concordant with the figure given by the French author, and agrees also with his diagnosis of *A. foliosus*. The branch is six millimeters thick, the articulations eight to nine millimeters distant, marked by two parallel inflated rings, leaving between them a furrow or depression of about one millimeter broad, where are distinctly seen the small, oval, horizontally enlarged tubercles, bases of leaves. A few of them are still preserved on the border of the stem. These leaves are exactly lanceolate, very sharply and gradually acuminate, distinctly nerved. The surface of the stem is a pellicle of coaly matter, indistinctly striate, the striæ being without correlation to the scars of the leaves. But under this thin bark, the broad, flat, or slightly convex ribs are seen, and they correspond to the tubercles. This specimen resembles, in a very reduced scale, f. 4, of Pl. V, in Grd. 'E., l. c., with this exception, however, that so far as can be seen, the leaves of our specimen are free to the base. This fragment seems to represent and explain the peculiar character of *Calamites disjunctus*, Lesqx., Geol. of Penna., p. 850, Pl. II, f. 5.

Habitat—Most of the specimens described are from the nodules of Mazon Creek. The cones of *Macrostachya* are from the upper shale of the Anthracite, near Pottsville, not rare. Also found at Cannelton.

ASTEROPHYLLITES GRANDIS, *St.*

Bechera grandis, St., Fl. d. Vorw., 1, p. 30, Pl. XLIX, f. 1. Ll. & Hutt., Foss. fl., I, Pl. XVII and XIX; III, Pl. CLXXIII.
Asterophyllites grandis, Gein., Verst., p. 8, Pl. XVII, f. 4–6.
Bechera delicatula, St., l. c., p. 31, Pl. XLIX, f. 2.
Calamites nodosus, Ll. & Hutt., Pl. XV and XVI.
C. cannœformis, Gein., Verst., Pl. XIV, f. 5.
Calamocladus grandis, Schp., Paleont. Veget., 1, p. 325.

Stems distinctly striate and contracted at the articulations: leaves open, narrowly linear-lanceolate, short, of thin texture; nerve indistinctly marked.

This species closely resembles A. *equisetiformis* It is separated by its shorter, more delicate, narrower leaves, generally open, flattened upon the stone, or slightly curved inward from the middle. I have never seen specimens of this species with large stems nor with leaves as long as one centimeter. The midrib is not easily seen, even with a magnifier. The stem is more distinctly costulate, and the internodes comparatively longer.

Bechera grandis, as figured by Ll. & Hutt., Pl. XIX, seems referable to the former species rather than to this one.

Habitat—The variety with small, narrow, delicate leaves, is common in the shale of the Anthracite coal of Rhode Island. Specimens with longer leaves are from Morris, Ill. The species is generally rare, except at the first mentioned locality.

ASTEROPHYLLITES FASCICULATUS, *Sp. nov.*, *Pl. III, Figs. 1–4.*

Stems comparatively thick; branches dichotomous, fasciculate or opposite, distinctly striate under the inflated articulations; internodes short; leaves short, lanceolate;

fructifications in narrow, linear spikes; sporanges oval in the axils of the leaves.

The main stem, f. 2, with opposite branches, as in all the species of the genus, is four millimeters at the base, gradually narrowing to the apex, with articulations one centimeter distant, inflated, also proportionately shorter in the upper part. In the tuft of branches confusedly mixed upon a separate specimen, f. 1, the largest is six millimeters broad, and the internodes much shorter, varying between three and six millimeters. The stems are distinctly obtusely costate, the ribs in the decorticated state corresponding to the round tubercles, points of attachment of the leaves. These are three to four millimeters long, sessile by their whole base, lanceolate-acuminate, or gradually tapering up to a sharp point. They seem as if joined at their base, an appearance caused by a narrow ridge of the cortex which surrounds the articulations, projecting just in the middle, covering the point of attachment of the leaves, which is distinct only under the bark in round small tubercles. The fructifications as seen, f. 3 and 4, are in spikes four millimeters broad, three to five centimeters long, bearing sporanges superposed upon the axils of the leaves. These sporanges were easily detached, as they are often found sparse upon the shale aside of the spikes, as seen f. 3, which, with the enlarging, f. 3a, 3b, 3c, show their mode of attachment as axillary by a very short pedicel, and their broadly oval form.

The ramification of f. 1 is in discordance with that of f. 2, and indeed with the mode of branching of all the *Asterophyllites*. I can explain it only in supposing that f. 2 shows a tuft of basilar branches, or rather of creeping rhizomas. But fructifications are found spread upon the specimens bearing these tufts, even with fragments of spikes, which essentially show the identity of both forms.

Habitat—Clinton, Mo. Shale above the coal; kindly presented in fine specimens, by Dr. J. H. Britts.

ASTEROPHYLLITES GRACILIS, *Lesqx. Pl. II, Figs. 4–5a.*

Geol. Rept. of Arks., II, p. 310, Pl. II, f. 4, 4a, (1860.)

Stems and branches very slender, obscurely striate; leaves *shorter than the internodes, in whorls of eight to ten, open, curved upwards; fructifications of the same character as in the former species, in spikes distinctly smaller.*

The species is very slender in all its divisions. The primary stem, at least as far as it is known, is, for the largest specimen a little more than one millimeter in diameter, more generally half as broad. The branches truly capillary in form and size, are simple or divided, oblique. The leaves of the main stem are three millimeters long, and those of the branches scarcely half as long, and all so narrow that it is not possible to distinctly see the costa. The spikes, f. 5 and 5a, are of the same character as those of the former species, differing, however, much by the size and the globular form of the nutlets.

Two other species, closely related to this if not identical, have been published, from the sub-conglomerate coal measures. The first, by Prof. Dawson, *A. parvula*, Can. Natur., vol. VI, p. 163, f. 6, a, b, c; the other by Prof. Andrews, *A. ? minutus*, Geol. Rept. of Ohio, Paleont., II p. 424, Pl. LI, f. 4, 4a. In both, but especially in this last species, the internodes are shorter, and the leaves more crowded. They have the appearance of *A. delicatulus*, Brgt., as figured in Roehl. Paleont., XVIII, Pl. II, f. 6. It is impossible, from the imperfect state of too small specimens, to definitively judge the value of the characters indicated as specific.

The likeness of Prof. Andrew's species to *A. gracilis* and to *A. parvulus*, is remarked by him.

Habitat—Sub-conglomerate Coal of Arkansas in small fragments. Woodworth coal mine, Alabama, Mr. J. H. Aldrich.

REMARKS ON FRUCTIFICATIONS OF ASTEROPHYLLITES.

Grand 'Eury, in resuming the result of his own researches and of the phytopaleontologists who have given attention to the subject, considers the organs described as *Wolkmannia* by Authors, as the spikes of *Asterophyllites*, which, he says, have not yet been referred to their respective species.

Among others he describes *Volkmannia gracilis*, Fl. carb., Pl. VI, f. 1, a branch only half as thick as the one of our Pl. III, f. 12, or like the fragment described as *Asterophyllites ovalis*, Lesqx., Geol. of Penn'a, 1858, p. 851, Pl. I, f. 2, and Atl., Pl. III, f. 5–7, a species referred by Feistmantel to *A. equisetiformis.* With this we have now the two other species described above, whose reference to their stem-bearing leaves is indubitable, and which, therefore, bear their true generic names. Another species of Grd. 'E. *Volkmannia pseudosessilis*, Pl. VI, f. 3, is partly reproduced on our Pl. III, f. 11, enlarged. It shows the sporanges as born upon a somewhat long pedicel, curved down, so that the ovules appear as placed between the articulations. F. 7, of our plate, represents a specimen in nodules from Mazon creek. The sporanges seem indeed pedicelled, either pending or supported higher than the axils of the leaves. It is impossible to positively ascertain the relative position of the ovules, therefore their reference to *A. ovalis*, or to *A. equisetiformis* is not sufficiently proved.

ANNULARIA, *Brgt.; Prodr.*

Stems articulate, striate, with a strong diaphragm traversing it at the articulations; branches opposite, nearly in right angle from the articulations; leaves verticillate, lanceolate, spathulate or lingulate, abruptly or gradually acuminate, sometimes obtuse, even emarginate at the apex; fructifications in long cylindrical spikes, with close articulations and narrowly lanceolate bracts, bearing round sporanges in the axils of the leaves, or double, oval ones, pedicelate and attached in the middle of the internodes.

These plants appear to have lived in water. The mode of division of the branches in right angle, and the disposition of the leaves in whorls not exactly circular, but generally with longer leaves in the upper part and on the sides, show that the branchlets and leaves were expanded upon the surface of the water or the mud of the swamps. The internodes were hollow, closed at the articulations by a solid diaphragm, which is seen upon remains of plants in an advanced stage of decomposition, as a white round spot surrounded by a ring, which unites the leaves at their base.

ANNULARIA LONGIFOLIA, *Brgt.—Pl. II, Figs. 1, 2, 2a, 2aa, Pl. III, Figs. 10, 12.*

Brgt. Prodr., p. 156. Germ. Verst., p. 25, Pl. IX. Gein., Verst., p. 10, Pl. XIX, Pl. XVIII, f. 8-9, (fruit). Roehl, Foss. fl., p. 28, Pl. IV, f. 6, 15. Feist., Boem. Steink. fl., p. 128, Pl. XV, f. 1-4. Heer, Fl. foss. Helv., p. 51, Pl. XIX, f. 4, 5. Lesqx., Geol. of Penn'a, 1858, p. 852., Geol. Rept. of Ill., II, p. 444. Schp., Paleont. Veget., I, p. 348, Pl. XXII, f. 5-10.
Annularia fertilis, St., Fl. d. Vorw., I, Pl. LI, f. 2.
A. spinulosa, St., ibid., p. 28, Pl. XIX, f. 4.
Bruckmannia tuberculata, St., ibid., I, p. 29, Pl. XLV, f. 2.
Asterophyllites tuberculatus? Ll. and Hutt., Foss. fl., Pl. XIV, (fruit).
Equisetum stellifolium, Harl., Trans., Geol. Soc. of Penn'a., 1, p. 261, Pl. XIV, f. 4, (1835).

Stem narrowly striate; leaves in whorls of eighteen to twenty-four, lanceolate, spathulate, more or less abruptly acuminate; medial nerve broad, distinct, fructifications in long cylindrical spikes.

The leaves vary upon the primary stems from one and one half to five centimeters long, and from two to three millimeters broad. They are generally largest above the middle, gradually narrowing downward to the point of attachment, and more rapidly to the acumen. The midrib is broad, deeply impressed, and the borders of the lamina reflexed or convex, as seen f. 2a, which, enlarged, shows the point of attachment to the ring, and 2aa, which represents the cross section of a leaf. Sometimes, especially upon shales, the leaves are flattened by decomposition and compression.

F. 12, of Pl. III, represents a fragment of a fruiting stem preserved in nodules. From outside appearance, it has the characters of the spike figured by Grd. 'E., Fl. carb., Pl. VI, f. 1, as *Volkmannia gracilis*, St., or fructifications of *Asterophyllites*, while f. 10 of the same plate, partly reproduced from Grd. 'E. l. c., f. 4, is referred by the French author to *Bruckmannia tuberculata*, St., considered as the fruit of *Annularia longifolia.*

Possibly the specimen represented f. 12, does not show the true character of the fructifications; for I have now from Cannelton a number of others, upon shale, which by thickness of the ribbed axis, disposition and form of leaves or bracts, are similar and where the ovules are not exactly axillary but placed between the whorls of leaves or in the middle of the internodes. This is seen by circular rows of deep points, scars of pedicels, even some of them still bearing fragments of pedicels, as in Pl. III, f. 10. I cannot distinctly see upon these specimens if the ovules are double; for they are generally covered by the whorls of bracts, pressed upon them, or by large flakes of macrospores, derived from the ovules, and so abundant, per places, that they cover the whole axis between the whorls, even part of the bracts. These spores, one millimeter in diameter, are half globular on one side, triquetre or tricostate on the other, like those of the Lycopodiaceous, Atl. Pl. LXVIII, f. 7*b*, LXIX, f. 9*a*, 13*a*. But on one of the specimens from Mazon Creek, some of the ovules are detached from the spike and scattered aside of it. They measure, flattened, one and an half millimeter in diameter and one of them is double, like those at the top of Atl. Pl. III, f. 10 None however are open and no spores are visible. And still, another specimen represents a spike, twelve centimeters long, with the axis as broad as that of f. 12. It has the articulations a little more distant, five to six millimeters, without any trace of points or scars of pedicels in the internodes. The ovules appear auxilliary and the whole is similar to the fine figure in Gein. Pl. XVIII, f. 8, copied in Schimper's Atlas, Pl. XXII, f. 8, as fruit of *A. longifolia*. From the evidence obtained of these fragments, we may well admit that they represent what the European authors consider as fructifications of *A. longifolia*, and also that these fructifications contradict the reference of these plants to the *Equisetaceœ*. The character of the spores is positively Lycopodiaceous though the subdivision of the stem and the disposition of the leaves or whorls have the character of the Equisetaceœ. The group of *Annulariœ* appears therefore intermediate and distinct. It should have been separated by Brongniart or Grand'Eury who have both observed the characters of the spores.

To this group is referable the plant described below as *Trochophyllum lineare*, which, as indicated from specimens discovered by Prof. E. B. Andrews, has Lycopodiaceous spores like *Annularia*, and inflated, club shaped, or linear obtuse leaves which though free to the base are in whorls and attached to semi-globose papillæ which takes the place of the rings of *Annularia*.*

Habitat—Very common in the coal measures, especially in the lower strata above the millstone grit.

ANNULARIA INFLATA, *Lesqx., Pl. II, Fig. 2b, 2bb.*

Geol. Rept. of Ill., IV, p. 423, Pl. XX, f. 1 to 3, (fine specimens). Schp., Paleont. Veget., III, p. 459.

Stem obscurely striate, rather smooth; branches and articulations as in the former species; leaves rather longer, more numerous, inflated, semi-cylindrical, club shaped and obtuse; costa none, or obscurely seen when the leaves are flattened by compression.

The essential character which separates this form from *A. longifolia* is the thickness of the leaves which, distinctly inflated, are club shaped and obtuse at the apex. This peculiar feature may be the result of habitat under water, or in more shaded localities; a casual inflation by superfluence or turgescence of the cellular tissue. The costa, then, is a central vascular bundle, as in leaves of *Stigmaria*. The number of leaves is somewhat greater, perhaps from the same cause. Schimper indicates for *A. longifolia*, twenty to twenty-six leaves per verticil. I could never see more than twenty to twenty-two upon the best preserved specimens, while in this species there are generally twenty-four to thirty-two in the large whorls. It is remarkable that the medial vein of this form is never seen flattened or depressed, as it always is, even in the inflated leaves of *A. sphenophylloides*, which apparently thicken sometimes under a similar influence.

This form has not been remarked by European authors;

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*This group shall be considered in detail, with figures for its illustration.

and indeed I have never found it distinct or with inflated sub-cylindrical leaves, except in the concretions of Mazon creek.

Habitat—Mazon creek, in nodules. I refer also to this form a few specimens from Cannelton.

ANNULARIA CALAMITOIDES, *Schp.*

Paleont, Veget., I, p. 349, Pl. XXVI, f. 1.

Stem thick; branches closely articulate; stem leaves long, erect, numerous; branch leaves shorter, linear lanceolate, gradually acuminate.

This species, beautifully represented by Schimper, l. c., is easily mistaken for a variety of *A. longifolia*. It is especially distinct by the long stem leaves, erect and appressed in whorls along the stem; by the more sharply acuminate leaves of the branches, which are not open, but curved at the base, and erect from the middle upward.

The species is very rare in the coal measures of this continent, and I can refer to it only a few specimens from the nodules of Mazon creek. The stems are a half to one and a half centimeters thick, when flattened; the leaves somewhat broader and shorter than in *A. longifolia*, some acuminate, others obtusely pointed, flat, of a thinner texture, the medial nerve being often preserved alone. Some of the specimens, with crowded top leaves, obtained in nodules, like that figured in Geol. Rept. of Ill., IV, Pl. XXI, f. 1., seem referable to this species.

Habitat—Mazon creek, in nodules. The best specimen I have seen, is No. 87 of the collection of fossil plants, in the museum of Princeton College.

ANNULARIA SPHENOPHYLLOIDES, *Zenk., Pl. II, Figs. 8, 9.*

Galium spenophylloides Zenk., Leon. and Bronn., Jahr buch 1833, p. 398, Pl. V.

Annularia sphenophylloides, Gutb., Gœa. v. Sachsen, p. 71. Gein., Verst. p. 11, Pl. XVIII, f. 10. Lesqx., Geol. of Penn'a, 1858, p. 852, Pl. 1, f. 5, 5a. Geol. Rept. of Ill., II, p. 444. Schp., Paleont. Veget. I, p. 347, Pl. XVII, f. 12, 13.

A. brevifolia, Brgt., Prodr., p. 156. Heer, Fl. foss. Helv., IV, p. 51, Pl. XIX, f. 6–9.

A. galioides, Ll. and Hutt., Foss. fl., Pl. XXV, f. 2.

Stem slender; branches opposite, in right angle to the stems; verticils flat, twelve to twenty leaves; leaves longer on the outside, spathulate, slightly emarginate, or obtuse, or abruptly apiculate, more or less recurved on the borders.

The leaves, of hard texture, vary from three to ten millimeters in length. With the disposition of the branches in right angle, and the close verticils, generally of the same size upon the same specimen, the plants present a very beautiful appearance, resembling small open roses flattened upon the stone. The large form with leaves more inflated, ten to twelve millimeters, resembles the smallest verticils of *A. inflata.* It has, however, a very broad medial nerve, and the apex of the leaves is either obcordate or tipped by a short acumen, (mucronate). In some specimens of this variety, the medial nerve is enlarged at the top of the leaves, forming a kind of receptacle, which resembles that of the fructifications of *Trichomanes*, a likeness still more remarkable when this enlargement of the nerve is, as generally, filled by a black pulverulent matter.

Habitat—Found in most of the strata of the coal measures above the Millstone grit; abounds in the nodules of Mazon creek. Is also at Cannelton and in the upper beds (Salem and Tunnel) of the Anthracite around Pottsville.

ANNULARIA MINUTA? *Brgt.*

Hor. C. Wood, Trans. Am. Philos. Soc., vol. XIII, p. 347, Pl. VIII, f. 2.

Branches very slender, thread-like; internodes distant; verticils with few very small spathulate obtuse leaves; nerve indistinct.

This plant is very small in all its parts; the stems as thin as thread; the internodes five to six millimeters long; the largest primary verticils only five millimeters in diameter, while those at the apex of the branches are scarcely two millimeters. The leaves, seven to eight in each verticil, are oblanceolate, larger above the middle, obtuse, gradually narrowed to the base.

As remarked by Dr. Wood, *A. minuta*, Brgt. Prodr. p. 155, has not been identified. It is considered by Ettingshausen as a variety of *A. radiata*, Brgt., a plant of a totally different character, and I believe that we have in the specimen described above what the French author has mentioned under this specific name.

Habitat—The fragment figured by Dr. Wood is in the cabinet of the Academy at Philadelphia, presented by Dr. Dixon, from the coal fields of W. Virginia. I have fragments of the same form from the Gate Vein, near Pottsville.

ANNULARIA RADIATA, *Brgt.*

Asterophyllites radiatus, Brgt., Class. d. veg. foss., Mus. d'hist. nat., VIII, Pl. XIII, f. 7, (not described). Gein., Verst., p. 11, Pl. XVIII, f. 6, 7. Schp., Paleont, Veget., 1, p. 349.

A. acicularis, Daws., Dev. pl., Quat. Journ. Geol. Soc., XVIII, p. 311, Pl. XIII, f. 16.

A. radiata, St., Fl. d. Vorw., p. 31.

Leaves long and slender, gradually narrowing from the middle to the base and upwards to the needle-pointed apex; verticils with few leaves, flat.

The verticils of this species have ten to fourteen leaves, six to twelve millimeters long, one millimeter broad in the middle, and the costa indistinct.

Habitat—It is rare in our coal measures, and apparently a sub-conglomerate species. I have seen a few specimens only of this, from a coal bed near Sharon, Tennessee, (sub-conglomerate.)

ANNULARIA EMERSONI, *Sp. nov.*

Stem comparatively strong, distinctly striate, divided as in A. sphenophylloides; verticils a little smaller; leaves thick, oblanceolate, taper-pointed; costa none, or immersed and obsolete.

This plant has the same general aspect as the small forms of *A. sphenophylloides*, and also about the same number of leaves, but these are all gradually acuminate, or taper-pointed, from the middle upwards, and without any trace of nerve. The leaves are two to four millimeters long, less than one millimeter broad in the middle; the main stem a little more than one millimeter. It differs from

A. minuta, by the larger and taper-pointed leaves; from A. *Dawsoni*, especially by the smaller size of the leaves, the absence of a costa, and the leaves more abruptly acuminate. I should, however, consider this last species as a large form of *A. Emersoni*, if the habitat was not so far different; Dawson's plant being referred to the Devonian, while the specimens we have, are all from an upper coal of the horizon of the Pittsburgh vein.

Habitat—St. Clairsville, Ohio; roof shale of the coal. Mr. E. V. Emerson.

ANNULARIA DAWSONI, *Schp.*

Paleont. Veget., 1, p. 350.

Asterophyllites latifolia, Daws., Dev. pl., Quat. Journ. Geol. Soc., XVIII, p. 311, Pl. XIII, f. 17.

Stem slender; branches in right angle; internodes somewhat distant; leaves in verticils of eight to ten leaves, elliptical-lanceolate, narrow, acuminate.

Differs from the former by the slender rachis, the leaves longer, distinctly nerved, and the verticils more distant, with fewer leaves. The substance of the leaves is not thick, rather membranaceous than coriaceous; the medial nerve distinct from the middle downward is mostly effaced towards the acumen. From the mode of division of the branches in right angle, and the unequal shape of the verticils, this species is evidently an *Annularia.*

Habitat—Warrior Coal seam, Ala. Mr. F. H. Aldrich. According to Prof. Dawson it is abundant in the lower coal of St. John, New Brunswick.

SPHENOPHYLLUM, *Brgt.*

Plant herbaceous; stems articulate, inflated at the articulations, pinnately, bipinnately divided; leaves verticillate, sessile, wedge form, with lateral borders entire, crenulate, dentate or laciniate-lobate at the upper margin; medial nerve none; veins straight, dichotomous; fructifications in cylindrical spikes, with bracts curved upwards in a sharp flexure from near the base; sporanges globular, in the axils of the bracts.—Pl. III, f. 8, 9, copied from

Grd. 'E., Fl. carb., Pl. VI, f. 11, as fructifications of S. oblongifolium, Gein.

This genus, beautifully illustrated in Schp., Paleont. Veget., Pl. XXV, constitutes a natural group, without analogy to any other of the ancient or present vegetation. Its range of distribution is from the Silurian to the top of the Carboniferous.

It is with *Sphenophyllum*, as with *Asterophyllites*, *Annularia*, etc. Some authors are disposed to refer it to the Phænogamous gymnosperms, while others consider it as positively related to the *Equisetaceæ*, from the mode of division of the stems and the fructifications. These plants, like the *Annularia*, were evidently water plants, whose emerging branches were expanded upon the surface. Some species have the leaves more or less divided, often expanded in the upper part of the whorls, according, it seems, to their growth, either on the surface of the water or above it.

SPHENOPHYLLUM SCHLOTHEIMII, *Brgt. Pl. II, Figs. 6, 7.*

Scheuchzer, Herb. diluv., p. 19, (1709).

Palmites verticillatus, Schloth., Beitr., 1, p. 57, (1804); Petref., p. 396, Pl. II, f. 24, (1820).

Rotularia marsileæfolia, St., Vers., II, p. 30, 33, (1820).

Sphenophyllum Schlotheimii, Brgt., Prodr., p. 68, (1822). Germ., Verst., p. 13–16, Pl. VI. Coemans & Kickx., Monogr., p. 10, Pl. I, f. 1, 1a. Lesqx. Geol. of Penn'a., 1858, p. 852, Pl. I, f. 8, 8b. Geol. Rept. of Ill., II, p. 444. Schp., Paleont. Veget., I, p. 339. Pl. XXV, f. 19–21.

S. emarginatum, Gein., Verst., p. 12, Pl. XX, f. 2, 2a, 7.

Verticils of five to nine leaves; leaves broadly cuneate, rounded and crenulate at the upper border; veins free at the base, much divided; spikes thick, cylindrical.

This species, the most common and most beautiful of the genus, is easily known by the undivided rounded upper borders of the leaves, which often appear entire or very slightly crenulate, but are sometimes acutely dentate, as seen in our figure. The whorls vary much in diameter, the leaves being from one half to nearly two centimeters long, and equally as variable in width. The spikes are rarely found attached to stems bearing leaves, and therefore it is rarely possible to refer them to their species.

Habitat—The whole thickness of the coal measures, from the millstone grit upward

SPHENOPHYLLUM EMARGINATUM, *Brgt.*

Class. d. Veget. foss., p. 234, Pl. VIII. Gein., Verst., p. 12, Pl. XX, f. 1,3,4. Heer, Fl. foss. Helv., IV, p. 53, Pl. XIX, f. 15. Lesqx. Geol. of Penn'a., 1858, p. 853. Geol. Rept. of Ill., II, p. 444. Schp., Paleont. Veget., I, p. 339.
Var. Brongniartiannum, Coem. & Kx., Monogr., p. 14, Pl. 1.
S. Schlotheimii, Ll. & Hutt., Foss. fl., Pl. XXVII.

Leaves narrower, truncate at the top, obtusely dentate, primary nerves confluent at the base.

This species differs from the former, merely by proportionately longer narrower leaves, cut horizontally (not rounded) at the upper margin, and the primary veins joined at the base and less divided. Its leaves resemble those of the main stem of Atl. Pl. II, f. 6. The species is easily confounded with the former.

Habitat—Upper coal measures. Anthracite basin of Pennsylvania, near Pottsville, Gate vein. Duquoin coal, Ill., etc., not common.

SPHENOPHYLLUM LONGIFOLIUM, *Germ.*

Sphenophyllites longifolius, Germ., Isis, p. 426, Pl. II, f. 2. Verst., p. 17, Pl. VII, f. 2.
Sphenophyllum longifolium, Gein., Verst., p. 13, Pl. XX, f. 15–17. Coem. & Kx., Monogr., p. 17, Pl. I, f. 4, 4a. Schp., Paleont. Veget., I, p. 340, Pl. XXV, f. 22, 23.
S. latifolium, Wood, Trans. Am. Philos. Soc., XIII, p. 347, Pl. VIII, f. 3.

Stem long, robust; leaves large, wedge form, bifid or entire at the upper border, with lobes merely crenate, or deeply dentate, or cut in acuminate laciniæ; veinlets numerous.

A beautiful, very large species of which we have many specimens showing its great variety. One of them, answering to the typical form, has the leaves three centimeters long, with the upper margin either merely crenate or obscurely bilobed, six in a whorl, forming nearly a circular verticil. The primary veins, two only, distinct and thick at the base, are repeatedly dichotomous in ascending, and join the borders, divided in twenty-four to thirty veinlets.

The epidermis of the leaves is transformed into a coaly layer, somewhat thick, and very closely lined lengthwise.

To this form is referable *S. latifolium*, Wood, l. c., which, at first sight, seems too different to be considered as a mere variety. But I have for examination a large specimen which, by the diversity in the shape of the leaves, shows still more marked deviations from the type. Its stem, eight millimeters broad, is striate lengthwise by two or three narrow ribs; its surface both in the corticated and decorticated state is smooth and the articulations scarcely inflated. The verticils bear six to eight leaves, comparatively very long (six centimeters), only ten millimeters broad in the middle, some of them entire, merely crenate at the upper border or bilobate, the lobes one centimeter long or more, entire or cut into thin linear laciniæ, five to seven millimeters long. The veins, very distinct and in two at the base, are divided four times up to the border where the veinlets number twenty-four to thirty-two. This beautiful species is, how ever, rarely found preserved in such fine specimens as this one, or with stems bearing leaves; more generally the fragments are single whorls, with shorter leaves, like the typical form first described. Geinitz, l. c., has three figures, which represent the three varieties of this species as described here.

Habitat—Rare but apparently distributed through the whole thickness of the middle coal measures. The specimen in the cabinet of Prof. Andrews is from Barnesville, Ohio, horizon of the Pittsburgh coal. I have a beautiful verticil in nodules from Mazon Creek. Some other fine fragments are from the coal of Cannelton, communicated by Mr. I. F. Mansfield, one representing exactly the form figured by Dr. Wood. Another with two whorls of broad leaves seventeen millimeters long, horizontally cut at the entire upper crenulate margin, is from Clinton, Mo., presented by Dr. J. H. Britts.

SPHENOPHYLLUM EROSUM, *Ll. & Hutt.*

Foss. fl., Pl. XIII. Bunb'y., Quat. Journ. Geol. Soc., Vol. III, p. 430, Pl. XXIII. Coem. & Kx., Monogr., p. 19, Pl. I, f. 5, 5a, 5b. Heer, Fl. foss. Helv., IV, p. 53, Pl. XIX, f. 11–14. Schp., Paleont. Veget., I, p. 341.
Sphenophyllum dentatum, Brgt., Prodr., p. 68 and 172.
S. emarginatum, Gein., Verst., p. 12, Pl. XX, f. 6.
Var. Saxifragæfolium, Coem. & Kx., Monogr., p. 21, Pl. I, f. 6c. Schp., Paleont. Veget., 1, p. 342.
Rotularia polyphylla, St., Fl. d. Vorw., I, p. 42, Pl. L., f. 4.
Sphenophyllum quadrifidum et fimbriatum, Brgt., Prodr., p. 68 and 172.
S. trifoliatum, Lesqx., Geol. of Penn'a, 1858, p. 853, Pl. 1, f. 7.
Sphenophyllites saxifragæfolius, Germ., Verst., p. 17, Pl. VII, f. 1.

Leaves narrowly cuneiform; upper borders truncate and sharply dentate; primary nerves confluent at base; veins six to twelve; verticils normally in six leaves, or in twelve by subdivision.

Var. Saxifragæfolium. Leaves wedge form, bipartite to below the middle; lobes cut into two deep, sharp teeth, or acutely dentate. Verticils as in the normal form in six or twelve by divisions.

The species is very rare in the American coal measures; at least in its normal form. I have not seen any specimens positively referable to it. Of the variety I have a good specimen from the upper coal of Ohio, a long branch, with distant articulations, slightly inflated, marked by one or two strong ribs, and leaves one centimeter long, with scarcely distinct veins.

Habitat—Roof shale of the St. Clairsville coal, horizon of the Pittsburgh coal.

SPHENOPHYLLUM BIFURCATUM, *Lesqx. Pl. II, Fig. 10, 10a.*

Geol. Rept. of Arks., II, p. 309, Pl. I, f. 2. Schp., Paleont. Veget., 1, p. 344.

Stem thick, deeply costate; articulations much inflated; whorls in six leaves, cut to below the middle in two lobes, more or less deeply bidentate; primary veins separated to the base and distinct, effaced into the divisions; fructifications in narrow cylindrical spikes; sporanges large, nearly globular, slightly contracted to the point of attachment in the axils of linear-lanceolate, acuminate bracts, which are open, slightly curved upward.

As Prof. Schimper remarks, in describing this species, l. c., it is so much like *S. saxifragæfolium*, that one might easily consider it as identical. The difference is, however, marked by the strongly inflated articulations of the stem, covered with a thick coaly cortex; by the regularity of the divisions in all the stems and branches of the specimens, and especially by the peculiar appearance of the leaves, which, sometimes cut in four or five lobes, have the lateral ones shorter, dichotomous-like, as in the subdivisions of the leaves of some *Hymenophyllites*.

The fructifications also may serve as diagnosis to this species; for the bracts are not sharply folded at the base, a character generally considered as proper to this genus; but open, only curved up as in *Asterophyllites*, resembling those of the spike of Atl. Pl. III, f. 5. The spikes are not seen attached to branches bearing leaves, however, but three of these are parallel, as if derived from a branch upon the same specimen, which bears nothing besides these fructifications but leaves and fragments of this *Sphenophyllum*. The habitat of the species in the sub-conglomerate measures, at least as far as known until now, seems to confirm the assertion that it is truly different from the European plant.

Habatat—Sub-conglomerate coal measures of Arkansas. Male's coal. Shale of the Harmon coal, near Hazelgreen, Ky., (sub-conglomerate.) The fruiting specimen (Sp. 13) is in the museum, comp. zool. of Cambridge.

SPHENOPHYLLUM CORNUTUM, *Lesqx., Pl. LVI, Figs. 5, 5b.*

Geol. Rept. of Ill., IV, p. 421, Pl. XIX, f. 1-5.

Stem thick, a little inflated at the articulations, obscurely striate; branches nearly in right angle; verticils in six leaves, joined above the base, broadly cuneiform, divided from the middle into seven or nine linear, obtuse, nearly equal lobes; veins distinct, flat, four to five at the base of each leaf, forking once only, each division ascending to the top of one of the lobes.

I found this peculiar species at Colchester, and had the opportunity of observing it in many fragments, mostly small, as the shale of the coal is very brittle. I have seen, however, a few of the detached verticils, nearly entire, circular. Part of one is figured *5a*. The leaves appear as glued on the borders near the base; but the lines which pass from the base to the acute sinusses, are lines of separation of the leaves, and do not represent veins, for all the veins of the leaves of the genus correspond to an expansion of the lamina into lobes. As seen from some detached leaflets fixed upon the borders of the stems, whose base is broadly cuneiform, the connection is apparent only, and due to superposition of the borders. The epidermis of these leaves is thin, smooth, of a dull black color.

Might not this peculiar form be merely a variety of the former species? Besides the peculiar mode of divisions of the leaves, the nervation is of a different character. The veins are flat, sometimes appearing as double, on account of their slightly inflated parallel borders. The stem, also is scarcely ribbed, and its coaly surface is thin. The subdivisions of the leaves are of the same character in all the fragments observed, either of the stem or of the branches.

Habitat— Colchester, Ill., horizon of the Morris coal.

SPHENOPHYLLUM OBLONGIFOLIUM, *Germ.*

Sphenophyllites oblongifolius, Germ., Verst., p. 18, Pl. VII, f. 3.

Sphenophyllum oblongifolium, Gein., Verst., p. 12, Pl. XX, f. 11–14. Coem. & Kx, Monogr., p. 26, Pl. I, f. 8, 8a. Schp., Paleont. veget., I, p. 344, Pl. XXV, f. 5–8, (*9, **bracts.***)

Stems slender, striate, inflated at the articulations, branches oblique, verticils in six leaves, small obovate-cuneiform, bifid at the top; lobes entire; *veins simple at the base, forking once under the lobes.*

This description is made from a fine specimen bearing stem and branches. The leaves are very small, three millimeters long, one and a half to two millimeters broad in the upper part, all cut into two angular or taper pointed perfectly entire lobes, the leaves having only one primary nerve, simple, forking under the divisions and entering each of them. This specimen is in concordance of character with the figures and description of Germar, l. c., except that the leaves are not oblong or obovate, but distinctly wedge-form, gradually and equally narrowed to the base and thus somewhat like those of *S. angustifolium* of the same author. Schimper remarks in the synonymy of this species, about the figures given by Germar, that the teeth of the lobes have not been represented, and indeed his f. 6, l. c., has the lobes tridentate, but f. 7 has them entire; hence this difference is of no account.

Habitat—Clinton, Mo., Dr. J. H. Britts.

SPHENOPHYLLUM FILICULME, *Lesqx.*

Geol. of Penn'a, 1858, p. 853, Pl. I, f. 6.

Branches slender, very long, filiform; verticils of six leaves, the lateral twice as long as the two inferior ones, all cuneiform, truncate at the upper margin; primary nerves two or three, separated at the base, forking twice.

There is often, in the verticils of *Sphenophyllum*, as in those of *Annularia*, an unequal disposition of the leaves, the lateral ones being somewhat longer than the others. But I have not seen, except in this species, this inequality so distinct and so persistent, for it is remarked without modification upon all and the whole of the specimens. The whorls being always composed of six leaves, the two lateral of each side are twice as long as those of the lower side. It is also remarkable that except in *Sphenophyllum* (*Rotularia*) *oblongifolium*, as figured by Germ. & Kaulf., Pfl. Abdr., Pl. LXV, f. 3, no fragment of any species of *Sphenophyllum* is represented by the authors with leaves of unequal length. This peculiar conformation is explainable by the mode of growth of the plants in expanding their ramifications at the surface of the water, and for this reason, I should have been disposed to consider this species as a variety of *S. erosum*, on account of the truncate upper borders of the leaves, if the other characters had been identical. But it is not the case. In *S. filiculme*, the stem or branches are very long, flexuous and slender; the epidermis of the leaves is thick, and upon it the veins are very distinct; but it is easily effaced or detached in pieces, and the under surface does not show any trace of venation. These two characters are not remarked upon *S. erosum.* And still, the primary nerves, two or three, are separated to the base while they are united in *S. erosum.* These differences appear to be persistent, for I have been lately advised by Prof's. Fontaine and White that they have found the species in numerous specimens in the upper coal measures of Virginia, and that from careful examinations they consider it positively different from any others of the Genus.

Habitat—The whole extent of the coal measures. I have from Clinton, Mo., a fine specimen, a simple branch, twelve centimeters long, received from Dr. J. H. Britts. Others are from Newport, Rhode Island; others still, from Gate Vein, New Philadelphia and Pottsville, Pa.

CALAMOSTACHYS, *Schp.*

This generic name is employed by Schimper for the description of spikes comparable to those of Atl., Pl. III, f. 17, 19, generally but still doubtfully considered as fructifications of *Asterophyllites.*

CALAMOSTACHYS PRŒLONGUS, *sp. nov.*

Spikes very long and comparatively narrow; scales appressed, linear, obtuse.

These spikes placed in the same direction, about one dozen of them, upon the same piece of shale, and flattened by compression, are seven to eight millimeters in diameter and fourteen centimeters long, some of them flexuous. The articulations, two millimeters distant, are covered with appressed, linear scales, joined on the borders, truncate or obtuse, about of the same length as the articulations.

The spikes differ from all the species referred by the author to this genus, first, by their great length compared to their width, and especially by the obtuse scales, which closely appressed and covering the whole stem, rather resemble those of *Machrostachya* than those of *Calamostachys.* The spikes are longer than those figured by Geinitz as *Asterophyllites foliosus*, Verst., p. 10, Pl. XVI, f. 4; twice as long and merely slightly broader than those of the splendid specimen of Roehl, Paleont., XVIII, Pl. VII, f. 1, described as *Volkmannia elongata*, and these two last species have the scales lanceolate acuminate. I should rather consider these spikes as referable to a new species of *Macrostachya*, but as yet no stem referable to this genus has been observed in connection with them.

Habitat.—Pittston, Pa., Ontario Colliery, Vein C, communicated by Mr. R. D. Lacoe.

MACROSTACHYA, *Schp.*

Plants arborescent, articulate; articulations close, cortex thin, smooth or very thinly striate; impressions of the internal surface plano-costate; furrows very narrow, alternating at the articulations; leaves appressed, linear, carinate in the middle, or marked with a medial nerve, acuminate, finally truncate; leaf scars marked upon the articulations by transversely oval rings, like the links of a chain; scars of branches verticillate, large, round, umbonate, with a stigmarioid central mamilla; spikes very large, cylindrical; bracts lanceolate, costate in the middle, imbricate, scarcely longer than the internodes.

MACROSTACHYA INFUNDIBULIFORMIS, *Schp.—Pl. III, f. 14, 17–20.*

Schp., Paleont. Veget., I, p. 333, Pl. XXIII, f. 13–18 (stems and spikes).

Equisetum infundibuliforme, Bronn, in. Bishoffs, Crypt. Gew., I, p. 52, Pl. VI, f. 4, 9, 10. Brgt., Hist. d. Veg. foss., p. 119, Pl. XII, f. 14–16. Gutb., Verst., p. 30, Pl. III b, f. 5, 6. Germ., Verst., Pl. XXXII, f. 3, as Equisetum. Weiss, foss. fl., p. 122. Grd' E, Fl. earb., p. 48, Pl. XXXII, f. 1.

Equisetites infundibuliformis, Gein., Verst., p. 3, Pl. X, f. 4–7 (8?), (Pl. XVIII, f. 1?).

Calamites verticillatus, Ll. & Hutt., II, Pl. CXXXIX.

C. Germarianus, Goepp., Foss. fl. d. Uebergsg., p. 122, Pl. XLII, f. 1.

Huttonia Carinata, Germ., Verst., p. 90, Pl. XXXII, f. 1, 2.

Asterophyllites tubereulata, Lesqx., Geol. of Penn'a., 1858, p. 852.

A. aperta, Lesqx., Ibid., p. 852, Pl. 1, f. 4.

The characters are the same as for the Genus.

My specimens represent two fragments of stems without leaves. These are known to me only from the description of Schimper, which I have translated here. Both specimens are much alike, one eight centimeters broad, with the scars of the spikes a little more than two and a half centimeters in diameter, the other in nodules, four and a half centimeters broad, has the scars one and a half centimeters transversely measured. Both have only one row of large scars, and under it the stem is closely articulate, the internodes being on both specimens only one centimeter wide. In the nodules, the leaf scars are very distinct, transversely oval, as in Schp., f. 14, l. c., nearly five millimeters horizontally, and two and a half vertically, bearing in the center a small circular mamilla.

The spikes are not always curved, as figured in Geinitz, but generally straight, oblong, or larger in the middle, narrowed upwards, acuminate, Atl., f. 19, and equally narrowed downward, either to a short pedicel or to a point of attachment, f. 18 and 19. The scales closely imbricated, are linear, contiguous on the borders to near the apex, where they are triangular acute, as at top of f. 17, or contracted into a sharp acumen, as f. 19 and 19*a*. Their apex is rarely distinguishable; for they are so closely appressed that the upper part of an inferior verticil imbricating the lower part of a superior one, they become confused by compression, and also generally broken.

I am not certain that f. 20 represents the same species. It may be a spike, in an advanced stage of maturity, with open verticils. It is described and figured from a deficient fragment in Geol. of Penn'a., 1858, l. c., as *Asterophyllites aperta.* The axis is striate, gradually enlarged upwards from the base, and the scales, all truncate, form across the stem a succession of open verticils like fluted collars.

From the narrowed base of f. 19 and 20, and also from the description of a fragment given with *Asterophyllites foliosus*, it would seem that these spikes were short pedicillate, while the impression, f. 18, which evidently represents the base of a spike of this species, tends to show that they were rounded and narrowed to a sessile base. F. 18 may represent the cross section of a spike near its base. Schp., f. 17, l. c., copied from Germar, shows at its base a short smooth pedicel, quite narrow comparatively to the spike. And Atl. f. 20, may represent a different species, even, as said above, be referable to another genus.

The figure of a spike of *Machrostachya*, as reconstructed by Grand 'Eury, Fl. carb., l. c., represents the scales coming out in right angle from the rachis, abruptly bent upwards and imbricated at or near the apex. Atl. f. 20 may be compared to that of the French author, in supposing that we have here the representation of the inside of a spike, with the horizontal base of scales preserved, while the upper part has been destroyed. But in the specimen which is represented, Geol. of Penn'a, l. c., the verticils are merely half open, inclined upwards from their base, in the same position as those of Atl., f. 19.

Habitat—Nodules of Mazon creek, Mr. S. S. Strong, Cannelton coal, the largest stem, and a number of spikes, some intermediate in size between f. 17 and 19. Specimens f. 18 and 20 are also from the same locality, all obtained by Mr. I. F. Mansfield.

EQUISETITES, *Schp.*

Plants arborescent; stems articulate; articulations surrounded with more or less distinctly costate sheaths, deeply dentate on the border.

EQUISETITES OCCIDENTALIS, *Lesqx., Pl. III, Fig. 15, 16.*

Stems small, narrowly ribbed lengthwise; sheaths long and thick, cut at the margin in short, triangular, acute, large teeth.

I have many specimens in nodules and one upon shale which seem to represent all the same species. One is the lower part of a stem, three centimeters broad, narrowed and rounded to the base, where it shows traces of short articulations. It is narrowly but distinctly striate, and except from near the point of attachment, there is no articulation but the one preserved with the sheath, four centimeters above the base. The line or articulation at the base of the sheath is marked by transversely oval scars precisely like those of *Macrostachya infundibuliformis.* The divisions of the sheath as indicated by a strong nerve, ascending to the points of the teeth, are about five millimeters broad, the teeth, partly imbedded into the stone, are short, apparently like those of f. 16.

F. 15 is also a sheath from a specimen in nodules. It is exactly represented, and is, like that of the former, of a very coarse texture, with thick, prominent nerves. It is narrowed and rounded to the base towards the line of insertion which is about one centimeter in diameter. Another specimen of the same kind shows the teeth distinctly as in f. 16, which is from a specimen upon shale flattened and not quite distinct in its lower part. It appears doubly nerved and may represent a different species.

Organs of this kind are extremely rare in our coal measures. I have never seen any in a tolerable state of preservation except those of the nodules.

Habitat—Nodules of Mazon Creek, Mr. S. S. Strong. Cannelton Coal, the specimen f. 16; Mr. I. F. Mansfield.

PLANTS DOUBTFULLY REFERABLE TO CALAMARIÆ.

TROCHOPHYLLUM, *Lesqx.*, (*nec Wood*).

Branches of small size, cylindrical; articulations marked by small tubercles scars of the points of attachment of the leaves; leaves verticillate, free to the base.

The name *Trochophyllum* was proposed by Dr. Horatio C. Wood, Proc. Acad. of Nat. Sci., Phil., Oct., 1860, p. 438, as a substitute for *Annularia,* which is preoccupied in the sub-kingdom of Mollusca by Schumacher, Essay Nat. Syst., 1817. *Annularia*, Brgt., Prodr., 1828, has been admitted by all the Phytopaleontologists of Europe, and the precedence in the use of the name for mollusca cannot authorize its elimination, employed, as it is, for a fossil plant. Even

Hochstetter has taken the name of *Annularia* in his Fl. II, p. 680, (1841), for a group of plants of the *Apocyneæ.* Moreover, as a generic name, *Trochophyllum*, which merely signify leaves in whorls, is too indefinite, and also not appropriate for plants whose leaflets are joined at their base by a ring (*annulus*). It may be used, as I do it here, for the provisory description of too incomplete vegetable remains representing a character common to different genera, and which has to be elucidated by subsequent researches. As seen by the descriptions of the so-called species, one of them is apparently referable to the *Lycopodiaceæ.*

TROCHOPHYLLUM LINEARE, *sp. nov.*, *Pl. III, Fig. 24–25b.*

Branches slender, indistinctly articulate; leaves in close verticils, linear, oblique, rounded and narrowed to the point of attachment.

The stems are only one and a half millimeters broad and flattened equally in their whole length, with articulations indicated merely by the small gibbous points of attachment of the leaves, like small tubercles closely placed in circular rows. The articulations are not quite one millimeter distant, the leaves broader than the stems, one to one and a half millimeters, rounded at the base to the point of attachment, or to a very short pedicel, and then linear, apparently obtuse, without any trace of costa. They were it seems of thin or soft texture. Flattened upon the stone, they become effaced or broken in the upper part as seen f. 24 and 25, so that the apex is scarcely distinct. F. 25*b* shows the scars much enlarged. They are not joined by groves or striæ.*

Habitat.—Found in a quarry of a sub-carboniferous sandstone at Newark, Ohio, by Dr. Roeminger, State Geologist of Michigan. The specimens, two only, are very small. The compound is a ferruginous soft grained sandstone.

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* Recently, and since writing the above, I have seen a number of specimens which evidently represent the same species, but under different characters, indicating the relation of these plants to the *Lycopodiaceæ.* The discoverer, Prof. E. B. Andrews, is preparing a description with figures of these plants found in the Waverly sandstone of Ohio.

TROCHOPHYLLUM CLAVATUM, *sp. nov., Pl. III, Figs. 21–23.*

Stem indistinctly articulate, striate lengthwise between the scars; leaves in right angle, ten to twelve in a verticil, as seen from the scars of the surface, spatulate, obtuse, marked in the middle by a medial nerve, inflated toward the point.

The branches four millimeters broad in the flattened state, were exactly cylindrical, and of the same size in their whole length, without transversal line of articulations. The verticils of leaves are about three millimeters distant, the leaves in right angle to the stem, eight to ten millimeters long, enlarged towards the obtuse apex, and gradually narrowed from below the middle to a small round point of attachment.

As seen from f. 21*a* to 23, the scars are round, deep points under the `bark, alternate (f. 21*a*), with a narrow ridge descending on both sides, and passing across and a little below the scars of the inferior verticils. Upon the bark, the leaf scars appear like small tubercles, either pointed or concave in the middle, f. 22–23*a*, enlarged. The narrow striæ depending from the scars, f. 23*a*, have the appearance of alternate short flat ribs. The articulations are not enlarged, but merely marked by the position of the leaves and of their scars. The bark is comparatively thick; the leaves often immersed upon the stone are rarely distinct, the lateral ones only are preserved.

These fragments have a kind of relation by the scars and the ribs of the stems to *Equisetites mirabillis*, St., *Eleutherophyllum mirabile*, Stur. Could they be branches of this remarkable species, so rare and so little known?

Habitat—Found in a bed of friable black shale in the barren measures, about one hundred feet lower than the Pittsburgh coal, between Irwin station and Pittsburgh, Pa. Mr. W. D. Moore.

FILICACEÆ. (Ferns.)

Fossil remains of this order of plants have been discovered in the Silurian of this continent and of Europe, as far down as the Cincinnati group. Here the remains of Ferns, branches or pinnæ of large size, already bear characters denoting an advanced stage of development.

The Lycopods, close relatives of the Ferns, have been found also in formations of the same period. But their remains are of diminutive size, stems without leaves, like those of plants of an incipient race. It may be surmised, therefore, that the origin of the Ferns is older, and probably contemporaneous with the first traces of land vegetation.

This fact is also indicated by the preponderance of the Ferns in the coal measures, a preponderance clearly manifested by the considerable number of their species, and by the enormous size of the plants.

Atmospheric moisture and a high uniform degree of temperature, essentially contribute to the vegetation of the Ferns. These elements were at the highest, and it seems, equally distributed over our planet, during the carboniferous period. Hence the luxuriance of the Ferns which, at this epoch, covering the low grounds, have contributed at least one half of the materials of the coal.

From the Carboniferous to the present time, Ferns are recognized in every formation, but gradually less predominant. For however abundant they may have been in some circumstances, they have never since entered into the composition of the deposits of combustible minerals, coal, lignite, peat, in as remarkable a proportion as in the carboniferous times.

The number of species of coal Ferns cannot be positively ascertained now, on account of the difficulty of their identification from fragments generally too small, representing mere parts of fronds, which may differ only in some of their sub-divisions. Thus, parts of one and the same frond have been sometimes described under different specific or even generic names. Prof. W. P. Schimper, in his last work on vegetable Paleontology, records eight hundred and seventy species of coal Ferns, but supposes that from the uncertainty of the determinations, the real number may not be above six hundred.

Considering, however, that a fusion of two or more species into one may as easily result of the similarity of some of the fragments, as a multiplication of species from the diversity of others, and considering also that the study of the coal flora of this continent has greatly increased the materials relating to its history, especially by some new types, species, even groups of Ferns, I am inclined to believe that this beautiful family is represented in the Carboniferous by more than one thousand species.

This number still remains far below that of the Ferns living and known at the present time, when more than three thousand species are known. But a comparison between the old and present floras, tending to give an idea of their characters and of their riches, cannot be made without taking into consideration the physical circumstances of the globe at the different epochs. The flora of the coal is limited to certain classes of vegetables by the absence of numerous types unknown at that time in the vegetable kingdom, while the uniformity of the climate over the whole surface of the earth reduces the causative influences, or the modification of forms or characters, to a degree equivalent to what they may be now, within the area of a single low island of the Pacific ocean.

The number of species of Ferns in the Phillipine Islands is three hundred. Java and South Eastern Africa have about four hundred. Counting the species of the islands of the Gulf of Mexico and of the Eastern inter-tropical coast range, six to seven hundred are recorded. In all the countries above mentioned, the variations of the climate, of the geological and geographical features, multiply ad infinitum the causes which may influence the vegetation and diversify the distribution of plants, to thus increase the number of species, even without taking into account the succession in the deviation of types resulting from the work of nature in space of time, or during the ages which separate the coal epoch from the present. It is evident that, considered on this point of view, the number of species of Ferns of the coal, compared with that of our epoch, indicates for that old formation a multiplicity, a diversity of vegetable forms of which the present flora cannot give an idea, even in the localities endowed with the most luxuriant vegetation.

It is upon the warm islands of the Pacific ocean and the Gulf of Mexico; also in the equatorial low region of Brazil, along the Amazon river, that this beautiful family of plants, attains now its greatest development. In these tropical regions, a comparatively large number of the Ferns becomes trees which sometimes reach to an altitude of one hundred feet. Rivaling the Palms by their shape, their port, they are superior to them by the elegance of their fronds and leaves, indefinitely cleaved into sub-divisions of exquisitely graceful and constantly varied patterns. Though high these trees may be, the diameter of the trunks, generally simple or without branches, and exactly cylindrical, is never considerable. It scarcely measures one foot. In this also the superiority of the vegetation of the Ferns at the coal epoch is evidenced, even in comparison with the present growth of these trees in the most favorable circumstances afforded by the climate; for in the carboniferous measures of Ohio and Kentucky, silicified stems of Ferns have been found, measuring, in their perfectly cylindrical shape, more than two feet in diameter.

The Ferns belong to the highest order of the Cryptogams (the Acrogens), plants with a distinct axis, growing from the apex only, composed of woody fibres and vessels. They have that in common with the *Equisetaceæ*; but they differ from them by the spiral development of their stems and branches, by their leaves, flat laminæ, either entire or divided in multiple sections, according to the characters of their compound venation.

Concerning their growth, the Ferns are perennial, herbaceous, climbing, or arborescent. The fronds, before expansion, are involute in spiral, like a watch spring, and gradually unfold in the development of their stems and branches. (*Circinnate Vernation.*)

As herbaceous, the Ferns grow in tufts from inflated rootstocks, (*rhizoma,*) or come out successively from a more or less elongated creeping organ of the same kind. A large number of the species of the Carboniferous are bushy Ferns, many of them of very large size, known merely by fragments of stems or branches with leaves. Parts of fronds are seen sometimes on the roofs of the mines, measuring from three to four meters, and proportionally large, with flattened stalks, fifteen to twenty centimeters broad.

As arborescent, the stems of Ferns are erect, cylindrical, and woody; their fronds, then, open successively from the top, expanding umbrella-like, by the curving back of their petioles, sometimes very long. In separating from the stem, they leave upon the trunk deep, oval scars, preserved during the whole life of the trees. Atl. Pl. 59 and 60.

Trunks of Ferns, mostly silicified, are plentifully found in the sandstone of the middle coal measures of Ohio and Kentucky. Their internal structure is distinctly preserved and may be studied by thin lamels, cut by the lapidary and polished appropriately for microscopical examination. In connection with the coal, the presence of tree Ferns is recognized, mostly in the roofing shale, by fragments of bark with scars of the petioles. Even impressions of scars are seen upon coal or coal shales without any remains of bark.

The rhizomas of bushy Ferns, generally of a soft, cellular, easily decomposed tissue, are rarely found petrified in the coal measures. Two species only, both American, are described by Schimper under the generic name of *Rhizomopteris*. They rather represent the bases of petioles than true rhizomas. A few remains of true root stalks, preserved in ferruginous concretions of Ill., are described in this volume.

The description of Ferns refers to the characters of their different parts as follows:

Fronds are the leaves of Ferns in their whole, including the stalks or petioles. They are either simple, without divisions of the axis; or branching, the branches (*pinnæ*) being primary, when attached to the main axis; secondary, as divisions of a primary pinna, and so on, tertiary, quaternary, etc. Hence the fronds are simple, simply pinnate, bi, tri, polypinnate.

The divisions of the petiole (*Rachis*), answer to the same description as primary, secondary, tertiary, etc. These divisions of the fronds are more or less arbitrary for fossil Ferns mostly found in fragments of pinnæ, whose fronds or primary divisions are often merely conjectural. The largest fragments of a compound pinna is generally considered as a primary pinna, often named leaf, and the description made accordingly.

For the description of Fern leaves or pinnules, sometimes named simple pinnæ, the same terms are generally used as those applied to the dicotyledonous plants. They are entire or lobed, pinnate, bi, tri-pinnate, compound, multiple, etc.*

The more important characters in the determination of the Ferns are taken from the venation and the fructifications.

The vascular structure of Ferns is composed of cords or indurated vessels or tissues, termed scalariform, which branch from the base of the previous frond into the nascent bud of the forthcoming one, and lengthen upwards with the growth of the plant. It consists of two or more cylindrical, flat or channeled filaments or chords, which, on reaching the leafy part of the fronds, divide and ramify through all its parts. The ultimate ramifications ending in the leafy part (lamina), and called veins, either radiate from the base of fronds or segments in a flabellate manner, or more generally are produced from a midrib (costa), which, in simple fronds, is a continuation of the vascular cords of the stipes, or in segments of fronds, a branch of the rachis from which they are produced.†

Therefore two essential types of venation are marked in the Ferns of the coal. Either the leaves or leaflets are without midrib. Then all the veins come from their base, or from the point of union to the rachis, and pass up towards the borders in expanding fan-like by multiple, alternate, forkings (dichotomy). The venation is then *flabellate* and *dichotomous*. Or the leaves or leaflets have a midrib or costa, from which the veins are produced, passing towards the borders, either in right angle to the midrib, or in a more or less acute angle, simple or forking in divers ways, straight, curved or flexuous, etc. In their relation to the midrib they are called primary veins; their divisions secondary or *venules*; the branches of these *veinlets*. The veins are called *forked* when they divide in two branches; *bifurcate* in more than two; *pinnate* when the primary veins produce venules either alternate or opposite in regular order on both sides.

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* Most of the botanical terms used in this volume are found in the glossary of Gray's Lessons of Botany. A few peculiar to phytopaleontology are locally explained.

† Historia filicum, by John Smith.

In living Ferns the leaves and pinnules of a number of species have an anastomosing venation, the *apices* of the branches of each proximate fascicle uniting with another and forming regular square, rhomboidal, or unequal-sided meshes. As yet this kind of venation has not been observed in any species of coal Ferns of this continent. The areolæ or meshes of *Dictyopteris* are formed by undulations of the veins, not by anastomose.

The fructification of the living Ferns offers quite as valuable characters for their determination and classification as the venation.

The fruit-dots are generally placed upon the lower surface of the laminæ or pinnules, in receptacles supporting or containing the (*sporanges*), capsules which bear the (*sori*), glomerules of seeds. But the position of the sporanges, their form, the disposition of the sori, are rarely distinct enough upon fossil specimens to offer reliable points of observation. In some cases, and for silicified specimens only, the characters of the fruit-dots have been distinctly seen and described. As until now no deposits of silicified fragments of Ferns have been found in this continent, it would be an useless task to base the classification of the Ferns of the American coal measures upon characters which cannot be, or have not been studied here. Even in Europe, after the remarkable publications (*the Systema and the Gattungen*), where Goeppert attempted to expose the classification of the fossil Ferns from their fructification, this system has been generally abandoned.

It is therefore upon the characters clearly seen, those taken from the distribution of the pinnæ and of their branches; from the forms and sub-divisions of the pinnules or leaflets, and especially from the venation, that the descriptions of the fossil Ferns are made.

Brongniart has proposed a simple and clear classification based on those characters. Though some carboniferous types may not find an appropriate place in it, it has been and is still now generally followed. It was given first in *Histoire des Végétaux fossiles 1828—1837*, and later somewhat modified in *Tableaux des Genres des Végétaux fossiles, 1849.* Schimper's lucid and abridged exposition of the system is as follows: *

1. Frond simple or with compound pinnules, free or adhering without midrib, or with a midrib appearing near the base, but vanishing upwards; veins dichotomous, flabellate. (*Neuropterideæ.*)

2. Frond bi-tri-pinnate, with pinnæ or pinnules narrowed to the base, flabelliform, entire or scarcely lobed; veins diverging from the base without a more distinct midrib. (*Adiantideæ.*)

3. Fronds like the former ones, diversely lobed; veins pinnate or bi-pinnate from the base; secondary divisions very oblique. (*Sphenopterideæ.*)

4. Fronds simple, pinnate or bi-tri-pinnatifid, with pinnules generally adhering by their base to the rachis, often confluent, forming only more or less deep lobes, entire or denticulate, not lobed; secondary veins pinnate or dichotomous. (*Pecopterideæ.*)

Another classification applied to living and fossil Ferns, and based also upon the venation, has been proposed by d'Ettingshausen in a work illustrated by physiotypical plates of great excellence. The divisions of the Ferns, as established by this author, are very numerous and cannot be easily understood without the illustrations. Schimper has also given a synopsis of this system, Paleont. Veget., I, p. 365, etc.

I have therefore, in this work, followed Brongniart's classification, with some changes in accordance to the characters of the plants which have to be described.

The first section is limited as indicated above by Brongniart; the second section is that of the *Alethopterids* allied to the *Neuropterids* by their nervation but evidently different by the fructifications.

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* Paleont. Vegét., I, p. 365.

The *Pecopterids* are left as described by Brongniart for the third section; and I admit to the *Sphenopterids* as a mere sub-division of this family, the *Adiantides*, especially represented by *Archæopteris*.

NEUROPTERIDS.

The Genera *Neuropteris*, *Lesleya*, *Dictyopteris* and *Odontopteris*, are the only ones which I refer to this section. They represent a very distinct, most interesting group of the Ferns of the coal, all bushy plants of great size, with broad rachis, pinnæ and pinnules of the most beautiful forms. Science has vainly searched for an analogy of these Ferns to some of those living at this time. No species of this group has passed above the Permian.

The first Genus admitted and described by Brongniart, in this section, *Cyclopteris*, was established for leaflets of great size, generally orbicular, as indicated by the name, related to *Neuropteris* by their venation, but which always found isolated, could not be positively referred to the original plants wherefrom they had been derived. To these the author added two species—*Cyclopteris digitata* and *C. flabellata*, which, related to the Jurassic types *Baiera or Salisburia*, do not find place with the Ferns. Of this kind are the Whittleseya, or allied types, represented in Atl. Pl. IV, f. 1–3.

By and by the true identity of the species of *Cyclopteris* (*Neuropterids*) which, later, Brongniart separated in his Tableau de Genres, under the name of *Nephropteris*, have been more or less positively identified as true *Neuropteris*, species which bear upon the same pinnæ, and according to the position which they occupy, some leaflets with a flabellate dichotomous venation, without any midrib (*Nephropteris*), and others with a distinct middle nerve, from which the veins curve in diverging and anastomosing toward the borders, true *Neuropteris*.

As this genus is widely represented in the North American coal measures, not merely by species whose characters are definite and often peculiar, but also by a prodigious number of specimens, sometimes filling whole layers of shale, it has been possible to follow the multiple variations of these plants, and to refer to their original types, separate leaflets which, seen isolated in collections, may be easily, and have been often, considered as representing different species. In the final report of the Geol. of Penn'a, 1858, I had already figured part of a pinna of *Neuropteris hirsuta*, Pl. III, f. 6, showing the relative position of large terminal pinnules marked with a distinct costa, to small basilar ones, leaflets with the characters of true *Cyclopteris*, without trace of medial nerves, all the veins being dichotomous and flabellate from the more or less enlarging base. In the same work are represented also, Pl. IV, f. 1–16, the extremely variable forms of the pinnules of the same species which could be identified by the hairs of the surface. Since then, in pursuing researches in the same direction, I have had opportunity to recognize the relation of the large leaflets, *Cyclopteris*, to different species of *Neuropteris*, either by immediate attachment upon the rachis of pinnæ, bearing both the neuropterid and the cyclopterid leaflets, as in *Neuropteris rarinervis;* or by evidence of some characters peculiar to both kinds of pinnules, as in those of *N. fimbriata*, *N. undans*, etc. Therefore, both genera *Cyclopteris* and *Nephropteris* are eliminated from this group.

Other devonian Ferns, described as *Cyclopteris*, by Geoppert, Unger, and Dawson, have been referred to *Archæopteris*, *Adiantites*, *Aneimites*, *Triphyllopteris*, and other divisions which have no relation to the Neuropterids. Two species of Goeppert, *Cyclopteris polymorpha* and *C. frondosa*, are separated by Schimper under the name of *Cardiopteris*, as intermediate to *Neuropteris* and *Odontopteris*. This type has not been recognized as yet in the fossil flora of this continent.

NEUROPTERIS, *Brgt.*

Fronds simply, bi, tri-pinnate; pinnules varying from round to ovate, obtuse, or obtusely acuminate, mostly entire, rounded, cordate, or auricled at the base, attached to the rachis by the middle; sessile, or rarely short pedicelled; veins either from the base of the pinnules or from a costa, diverging fan-like and arched backwards, in passing towards the borders, many times dichotomous; costa generally dissolved at or below the middle; basilar veins simple or in fascicles.

The question concerning the characters of the fructifications of *Neuropteris* is still undecided, and demands some consideration.

Brongniart, Hist. d. Veg. foss., has represented a leaflet of *Neuropteris flexuosa*, Pl. 65, f. 3*a*, bearing at the forking of the veins, between their branches, in the proximity of the mid-rib, small, oblong, obtuse tubercles, resembling sporanges, which he considered as fructifications of this species. Later, recognizing the same kind of organism upon a specimen of *Pecopteris Defrancii*, preserved in the museum of Strasburg, he abandoned his first opinion, from the fact that, upon some of the pinnules, these small excrescences did cover the whole surface, while in others, few only were seen between some of the veins, and others still had none at all. He further remarks, that their repartition had no regularity, like the fructifications of Ferns, and that he has seen alterations of the parenchym, by parasite Cryptogams, upon living Ferns of different genera, *Polypodium*, *Aspidium*, *Pteris*, etc., presenting the same appearance. These organisms have been observed often since by phytopaleontologists. I figured them already in Geol. of Penn'a, 1858, Pl. V, f. 3, attached to the leaflets of *Neuropteris gibbosa*, remarking, p. 858, that there were near the midrib, between the veins, and exactly following their directions, some short narrow depressions which, by their form and symmetry did appear of an organic nature; but that it was not possible to ascertain if they were truly the fructifications of these plants. Since then, I have found them always of the same form, in the same position, in one, two, or more rows, near the costa, at the forks of the veins, between two branches, and following their direction, therefore more or less oblique to the mid-rib. They are, as described above, mammillate or inflated, sometimes, when in a mature state, apparently concave, the oval small, cavities appearing as bordered by a narrow rim; mostly all of the same size, about one millimeter long and half as broad. A number of specimens of *Neuropteris Clarksoni*, *N. hirsuta*, *N. Loschii*, etc., in the cabinet of Mr. Lacoe, of Pittston, abundantly bear those small mammillæ upon the leaflets.

Professor Heer has observed upon the under side of the pinnules of *N. flexuosa*, another kind of tubercles, placed in two regular rows, following the directions of the veins, oblique to the midrib, and in the middle of the space between the costa and the borders. From their regular position, he considers them as fructifications, and as different from those which he has seen also upon the same species, and which he says are always irregularly placed, and of the same character as those described by Brongniart. I do not put into question the reality of the observation of my celebrated friend. I must say, however, that upon many specimens I have seen those tubercles not merely at a distance from the midrib, but generally in a regular order of distribution, following always the direction of the veins, and of course either nearly parallel to the costa, or in various angles, according to their distance from it, even nearly at right angles when placed between veins very curved, and toward the middle of the laminæ.

On another side, the observations of Brongniart on the likeness of small parasite plants seen upon living species of Ferns and similar to those of the Neuropterids is correct. I have seen these parasite, species of *Hysterium*, also upon the leaves of *Salisburia*. But in these as upon living Ferns, the tubercles though generally placed between the veins and parallel to them, are sometimes across or traversing them in right angle, a position that I have never observed upon the supposed sporanges of *Neuropteris*.

The fact of these being true sporanges is confirmed in some degree by the discovery of the fructifications of *Odontopteris* by Grand 'Eury, described, Fl. Carb., Pl. XIII, f. 4. The sporanges are about of the same form as those of *Neuropteris* but borne upon the point of the veins or of their branches on the border of the leaves. It may be, therefore, that the fructifications of *Neuropteris* are sporanges, always placed between the veins, either irregularly scattered in the middle of the leaflets or in some cases disposed in one or two regular rows as seen by Prof. Heer.

These remarks show the insufficiency of the characters offered by the fructifications for the determination of fossil Ferns. The observations of Brongniart have been published in 1828, and since then, or for half a century, paleontologists pursuing their investigations into the nature of the remarkable group of the Neuropterids, have not been able even to positively ascertain if the tubercles so rarely observed upon the leaflets are mere parasite protuberances or true sporanges. With few exceptions the veins of the Neuropterids are distinct, and their position, carefully compared, especially their number as counted in a given space along the borders, ought to be mostly taken in account in the specification of their fossil fragments.

From their relative affinities the species of *Neuropteris* are grouped in four sections *Cyclopterids*, *Nephropterids*, *Euneuropterids*, *Pachydermate* and *Anomalous Neuropterids*.

§ 1. CYCLOPTERIDS.

NEUROPTERIS RENIFORMIS? *Brgt., Pl. IV, f. 5.*

Cyclopteris reniformis, Brgt., Hist. d. Veg. Foss., p. 216, Pl. 61, bis, f. 1.
Nephropteris reniformis, Schp., Paleont. Veget., 1, p. 430.

Leaflets symmetrical, round, entire, slightly undulate on the borders, deeply indented at the point of insertion; veins distinct from the base, diverging fan-like, arched, dichotomous and distant.

Except the characters of venation, little is known of this species described by the author from mere fragments. His figure represents only the lower part of a leaflet, precisely the part which has been half destroyed upon our specimen. It merely shows identity in the form of the pinnule. But in the European species, the veins, simple at the base and divided in outside branches, are rather pedate than dichotomous, and this character is not distinctly observable upon our fragment. The American form differs from *Cyclopteris orbicularis*, Brgt., which I consider as identical to *Neuropteris rarinervis*, by its thick coriaceous texture and smooth surface. The veins are thin or divided in two or three parallel vascular filaments, deeply immersed into the parenchima which thus upraised in the intervals, takes the appearance of very thick obtuse veins. The distance of the veins along the border is three fourths of a millimeter. It is not possible to distinctly see upon our specimen if the base of the leaflet is auriculate. It appears as if the fragment of stem closing the notch was pressed upon the border of the lamina, either casually joined to the leaflet, or perhaps a fragment of rachis to which it was attached.

Habitat—The two only leaves known of this Fern were found in a lot of specimens sent for determination by Prof. E. A. Smith, of Tuscaloosa, Ala. One of them, indicating the outlines of the leaves, is figured; the other is very fragmentary. The specimens have no labels. The color and consistence of the matter, a gray soft shale, are the same as in other fragments obtained from Helena mines, Ala. As I have never seen the species in the middle coal measures, its origin in the sub-carboniferous coal of Alabama is more than probable.

NEUROPTERIS DILATATA, *Ll. & Hutt.*

Cyclopteris dilatata, Ll. & Hutt., Foss. fl., II, Pl. 91. B.
Nephropteris dilatata, Schp., Pal. Veget., 1, p. 430.

Leaflets very large, transversely oval; texture thin; veins distant, dichotomous, diverging fan-like.

This species is as yet represented in our flora by two splendid specimens, leaflets, one measuring fourteen centimeters transversely, and seven in vertical line; the other, twenty-two centimeters by eleven. The base is expanded in large auricles, passing around the circular point of insertion and overlapping each other. In the largest leaf, the overlapping borders are erased, but they are still two and a half centimeters broad where they join each other under the point of attachment. The borders are undulate; the veins fifteen millimeters apart, or twice as distant as in the former species, irregularly inflated, sometimes split into two parallel fascicles, rarely in simple thread-like filaments. These leaflets clearly represent the English species distinguishable from the former as from any congener by the large size, the lateral widening, the thin substance of the lamina, and the distant veins. I have been unable as yet to recognize these characters in any other of the American Neuropterids.

Habitat—Clinton, Mo. Lower coal measures. Communicated by Dr. John H. Britts.

NEUROPTERIS TRICHOMANOIDES? *Brgt., Pl. IV, Fig. 4.*

Cyclopteris trichomanoides, Brgt., Hist. d. Veg. foss., p. 217, Pl. LXI, bis. f. 4. Lesqx., Geol. of Penn'a, 1858, p. 856. Schp., Paleont. Veget., 1, p. 421. Heer, Fl. foss. Helv., IV, p. 17, Pl. VI, f. 16.

Leaflets nearly round and equilateral, deeply notched at the point of attachment, entire or undulate; veins thin, dichotomous, flabellate, nearly straight or slightly arched in passing to the borders, where they become very close.

I have figured the largest of the leaflets referred to this species. It is somewhat more enlarged on one side than on the other. A number of others from the same locality are precisely equilateral, with borders slightly undulate, as in the specimen figured by Brongniart. The thin veins are free to the base, not fasciculate, close, especially so, near the borders, where they become scarcely distinct to the naked eye, there numbering forty to fifty per centimeter.

These large leaflets are not rare at Cannelton, where also are found separate neuropterid pinnules and fragments of pinnæ of a species which I have referred to *Neuropteris capitata*, Atl. Pl. XXIII, f. 2, 3. The venation of all these specimens is of the same character. The fragment, f. 1, is from Illinois. It differs by the veins slightly more distant, though quite as thin. No cyclopterid pinnules have been found in connection with it. It is, therefore, possible that the Cannelton plants, both the small and large leaflets, may represent a new species, though they have as characters the same peculiar enlargement of the terminal pinnules indicated by the specific name. On another side, the specimens referred to this species in Geol. of Penn'a, 1858, have the same character of venation as those of Cannelton, but the fragments of *Neuropteris*, seen at the same locality, represent mostly *N. cordata*, or *N. angustifolia*, Brgt. The identification of the American specimens with the species of Brongniart is, therefore, doubtful. It is based only on the similarity of shape and size of the leaflets, and on the same distribution of the veins, which, according to the remarks of the author, are thin and very close on the borders.

Habitat—Gate Vein, near Pottsville. Not rare in the shale at the base of the bed of Cannel coal, at Cannelton, Pa.

NEUROPTERIS LACINIATA, *Lesqx.*

Geol. of Penn'a, 1858, p. 855, Pl. XIX, f. 3.
Cyclopteris laciniata, Lesqx., Boston Jour. S. N. H., Vol. VI, p. 416.

Leaflets thick, quadrato-orbicular, cordate; borders fringed, from below the middle upwards, by long, flexuous, thread like, acuminate divisions; veins dichotomous, flabellate, very close, nearly straight.

By its nervation, the leaflet is related to the following species, but it greatly differs by its thick texture and the scaly surface obliterating the nervation which is seen only when the epidermis is destroyed. The fimbriate divisions of the borders are also much closer and thinner. It seems to represent the cyclopterid form of *Odontopteris squamosa*, found at the same locality, whose venation and thick epidermis are of the same characters. This last species however has the leaflets entire. But the upper pinnæ of *N fimbriata* presents the same difference, the large leaflets only being fringed.

Habitat—Muddy Creek vein, between Pottsville and Tremont, Pa.

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§ 2. NEPHROPTERIDS.

NEUROPTERIS FIMBRIATA, *Lesqx.*, *Pl. V*, *Figs. 1–6.*

Geol. Rept. of Ill., II, p. 430; IV, p. 384, Pl. VI. f. 4. Schp., Pa'cont., Veget., III, p. 474.

Cyclopteris fimbriata, Lesqx., Boston Journ., S. N. H., Vol. VI, p. 416 Geol. of Penn'a, 1858, p. 855, Pl. IV, f. 17, 18.

Fronds bi-tripinnately divided; primary pinnæ apparently large, triangular in outline; secondary divisions linear, slightly oblique; pinnules alternate, oval or oblong, obtuse, rarely entire, generally fringed from the middle upwards, distant, attached to the rachis by a broad base, the upper ones slightly decurring; veins distinct, flabellate and dichotomous from the base; rachis finely equally striate, more or less punctate.

The first specimens found of this species are the large cyclopterid leaflets figured, Geol. of Penn'a., 1858, *l. c.*, one of which f. 6 is copied. Later, this species was found in Illinois in numerous specimens, representing its various characters. A part of a pinna with smaller leaflets attached to a flexuous rachis, f. 3, was described in both the Repts. of Ill., Vol. II and IV. Others of cyclopterid form like f. 2, show the mode of distribution of the leaflets upon the rachis; a third, f. 1, is a pinna with small pinnules mostly entire, some of them, as seen on the right part of the figure, having the top already slightly laciniate, while f. 4 and 5 represent detached and isolated pinnules of the same characters. We can thus follow the divers forms of the leaves in their connection with the upper pinnæ, or with the lower branches. They preserve the same characters, the shape only being modified in the cordate base, as in f. 4 and 5, without any variation in their venation. The texture is not thick, rather delicate, the veins always distinct, forking generally twice, in the small leaflets, f. 1; far more distant and distinct than in *N. Loschii*, Brgt.; even more distinct than in *N. tenuifolia*, Brgt., both species to which the upper branches with small pinnules are comparable by their size and shape.

Prof. Heer considered the first specimens of this fine species as perhaps representing fruiting pinnules of some *Cyclopteris*, or as having had the border casually lacerated by maceration and compression. But later he obtained from the anthracite of Switzerland a species, *Cyclopteris lacerata*, with leaflets laciniate like ours by a natural subdivision of the borders, differing, however, by a more dense nervation.

Habitat—Salem vein (upper coal measures); Pottsville, New Philadelphia, Pa. I have seen it in private collections at Charleston, Va., and abundantly in nodules procured from Ohio, in the cabinet of Dr. Hildreth, of Marietta. The geological station of these last specimens is unknown to me. As the species is not rare in the low coal of Morris, Ills., and in the nodules of Mazon Creek; as it is present, also, at Cannelton, and indeed in most of the collections which I have examined, it appears generally distributed in the middle coal measures, from the Conglomerate upwards, as far up as the Salem vein. It has not been found, as yet, in the sub-carboniferous measures.

NEUROPTERIS DENTATA, *Lesqx., Pl. V, Figs. 7, 8.*

Boston Journ., S. N. H., Vol. VI, p. 418. Geol. of Penn'a, 1858, p. 859, Pl. V, f. 9 and 10. Schp., Paleont. Veget., I, p. 447.

Cyclopteris undans, Lesqx., Ibid., p. 855, Pl. IV, f. 21, 22.

Pinnules ovate, obtuse, truncate or subcordate at the base, irregularly lacerate-dentate, and lobed in the upper part; veins dichotomous, flabellate, slightly arched in passing to the border, thin, close.

We have still here the neuropterid and cyclopterid forms of a species which is extremely rare in our coal measures. The outline of the pinnules is about the same as in *N. fimbriata;* but the venation is quite different, the veins being thin, close, slightly arched; and the texture of the pinnules thick, hard, and rigid. No remains of rachis have been found in connection with these leaflets, though the three pinnules on the left of f. 7 appear to be, or to have been attached to a rachis (destroyed). I considered at first the large pinnules as different, and from their close, rigid venation supposed them to be cyclopterid form of *N. undans*. They differ, however, by more distinct, stronger veins, and by the dentate borders. By the nervation, this species is allied to *Cyclopteris ciliata*, Heer, Fl. foss. Helv., IV, p. 17, Pl. VI, f. 24, in the same degree of affinity that *N. fimbriata* is to *Cyclopteris lacerata* of the same author.

Habitat—Blakely and Gate veins, near Pottsville, Pa.

NEUROPTERIS ROGERSI, *Lesqx.*, *Pl. VI, Figs. 7–10.*

N. speciosa, Lesqx., Boston Journ., S. N. H., Vol. VI, p. 417.

N. Rogersi, Lesqx., Geol. of Penn'a, 1858, p. 856, Pl. VII, f. 2. Schp., Paleont. Veget., I, p. 445.*

Pinnæ or pinnules large, oval, or ovate-lanceolate, obtuse, or obtusely pointed, even slightly cuspidate, deeply cordate or distinctly auricled, entire; veins dichotomous from the base or from a thin middle vein, flabellate, slightly arched, very distinct, turning upwards in reaching the borders.

The pinnules vary in size from four and a half to fourteen centimeters long, and from three to six centimeters broad, below the middle, where they are the widest. Some of them, like f. 7, are oblong-lanceolate, comparatively narrow; others, like f. 9 and 10, are much shorter, comparatively broad, nearly oval, generally with a symmetrical base, but sometimes with one side slightly more enlarged and prolonged downward. This character seen, f. 9, indicates that these pinnules are not simple, but were originally attached to a common rachis, though all have been found isolated. The nervation is rather neuropterid, as generally the pinnules have a narrow costa, not thicker than the lateral veins, appearing like a continuation of them. But in some specimens, in the small leaflets especially, the veins are all flabellate from the base.

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*The change of name was made with the assent of Professor Henry D. Rogers, the director of the survey of 1858, to whom the finest species then known from the coal flora of this country was appropriately dedicated.

This species is not comparable to any of the congeners. From *N. hirsuta* and *N. angustifolia*, both species very variable in the form of the leaflets, it differs by the more distant equal, sharp veins, not inflated or fasciculate toward the base, abruptly turned up along the borders, and equi-distant in their whole length; by the thin substance of the leaflets, their smooth shining surface and the deeply cordate auricled base, always marked by a comparatively small circular point of attachment. It is one of the most beautiful and most rare of the American species of *Neuropteris*.

Habitat—South Salem vein, behind Port Carbon, Pa., found in roof shale from an abandoned shaft, just north of the village, and also opposite on the other side of the creek in the same vein, from a thin bed of coal which was still worked in 1868. The pinnules are rarely orbicular. I found only one of this shape and even not distinct enough to positively show specific identity. Recently, 1879, two specimens of this species have been sent from Cannelton, Pa., by Mr. I. F. Mansfield.

NEUROPTERIS GIBBOSA, *Lesqx., Pl. VI, Figs. 1–6.*

Boston Jour. S. N. H., Vol. VI, p. 418. Geol. of Penn'a, 1858, p. 858, Pl. V, f. 3.

N. Undans, Lesqx., Boston Jour. S. N. H., Vol. VI, p. 418. Geol. of Penn'a, 1858, p. 859, Pl. V, f. 1–2.

N. gibbosa and N. undans, Schp., Paleont. Veget., I, p. 446.

Pinnæ large, linear-lanceolate; pinnules oblique, subalternate, lanceolate or oblong, obtuse, cordate or truncate at base, more or less deeply undulate on the borders; veins flabellate from the enlarged base, very thin, many times dichotomous.

From the examination of numerous specimens referable either to *N. undans* or to *N. gibbosa*, I now believe that they all represent the same species. The separation could be made merely from the surface of the pinnules, shining or smooth in *N. gibbosa*, dull or dusky black in *N. undans*.

I generally found the veins in this last form more inflated towards the base even fasciculate. But these differences are of too little specific value. The terminal pinnules, large and undulate, represented, Geol. of Penna., 1858, Pl. V., f. 1–2, have not been observed in any other specimens. They seem however reproduced on a reduced scale in f. 4 and 5 of our plate, small upper pinnæ of the same species. The lateral pinnules are not distinctly undulate and the terminal ones not as large. They have all the same kind of venation. The round leaflet is evidently attached to the broken base of a pinna bearing the lateral pinnules in the upper part of the specimen. F. 6 is the cyclopterid form of the same species with characters of nervation similar to those of F. 20, Pl. IV., of the Geol. of Penna., 1858. Its analogy is with *N. auriculata*, Brgt., from which it especially differs by the longer, lanceolate, narrower and equal leaflets.

Habitat—Upper Anthracite Coal measures, Gate and Salem veins, near Pottsville, Pa. I have received also the cyclopterid form from Cannelton, one specimen only.

NEUOPTERIS AURICULATA? *Brgt., Pl. VI, Fig. 11.*

Brgt., Hist. d. Veget. foss., p. 236, Pl. LXVI.
Germ., Verst., p. 9, Pl. IV. Schp., Paleont. Veget., I, p. 443.

Frond large, bi-pinnate; pinnules open, round, reniform or oval, sessile, and attached by a large base, cordate or auriculate, with borders undulate or sinuate; costa merely basilar or none; veins diverging from the base, very thin and close.

I am unable to ascertain if the fragment figured here, represents the European species. I have, as yet, not seen any other specimen of the American coal flora which could be positively referred to *N. auriculata*. This fragment does not show the characters of the middle pinnæ represented by Brongniart; but Germar, who has described this species also, and given a fine illustration of it, *l. c.*, has, in f. 2, the upper part of a pinna, with two lateral leaflets and a terminal one so perfectly according in character with the fragment figured here, that it would not be possible to doubt identity, if the veins were somewhat more curved in our specimen. This species, if truly American, is extremely rare in our coal measures.

Schimper rightly refers *N. Villersii*, Brgt., to this species. The plant described under this last name in Geol. of Penn'a, 1858, p. 858, Pl. III, f. 3, has its leaflets of a different size on each side of the pinnæ, in the same way as in the figure given by the author, but the lateral veins are more distant, stronger, and not as curved. It is probably referable to *N. callosa*.

Habitat—Cannelton, Pa., Mr. I. F. Mansfield.

NEUROPTERIS INFLATA, *Lesqx., Pl. VII, Fig. 2–4a.*

Geol. Rept. of Ill., II, p. 431, Pl. XXXVII, f. 2. Schp., Paleont. Veget., III, p. 475.

Filicites conchacus? Germ. & Kaulf., Abdr., p. 227, Pl. LXVI, f. 5.

Bi-pinnate; rachis thick, irregularly striate; pinnæ linear; pinnules alternate or sub-opposite, oval, obtuse, rounded to the base, sessile; veins flabellate and inflated from the base, dichotomous, curved, thin and close along the borders; upper surface convex.

Comparing the fragment of pinna, f. 4, with that f. 2, it is at first difficult to admit them as representing the same species. The peculiar form of the oval leaflets, rounded to an enlarged point of attachment, slightly enlarged at the inferior basilar rounded corner; the nervation, veins inflated, and thus apparently thick towards the base, becoming very thin and close along the borders, where they count 25–30 per centimeter; the convex surface, the distant pinnules, slightly oblique, and the comparatively broad rachis, all present the same character. The thick rachis of the large pinna, f. 2, ascends high up into the terminal leaflet. The second pinnule in descending preserves still an acuminate fragment of the rachis, but except this, the venation is exactly cyclopterid. The difference in the size of the pinnules is very great. The large ones, f. 3, are four and a half centimeters long, and as broad, while those of the pinna, f. 4, are only fifteen millimeters long, and six broad. A difference quite as marked is seen in other species of *Neuropteris;* e. g. *N. Clarksoni*, etc., and indeed it is often a difficult task to ascertain the identity of the pinnules of the upper pinnæ with those of the lower ones.

Filicites conchaceus, Germ. & Kaulf., shows by the figure and the remarks of the authors, a great affinity to this species. In the description, they compared the pinnule to a flattened Pectinite or shell, and mention the veins as close from the middle upwards, and very thin along the borders. The two opposite leaflets figured in the Geol. Rept. of Ill., *l. c.*, present the same appearance as also the one f. 3, of our plate. But the fragment of a single leaflet, which the German authors had for examination, is too imperfect; even the borders are erased in the whole circumference, and the description of the venation is incomplete. From it, the pinnule may be referred quite as well to *Neuropteris Germari.*

Habitat.—All the specimens seen from this species, representing large leaflets, are in nodules from Mazon creek. The others, small ones, as f. 4, are from Montevallo coal mines, Ala., communicated by Mr. T. H. Aldrich.

NEUROPTERIS COLLINSII, *Lesqx.*

Geol. Rept. of Ill., IV, p. 382, Pl. V, Figs. 5, 6. Schp., Paleont. Veget III, p. 473.

Pinnules large, ovate or obovate, broadly obtuse, entire; base truncate, large; veins inflated at the base and there distant, dichotomous, slightly arched, becoming thin, close, and more divided from the middle upwards.

The venation and the large size of the pinnules are the same in this species as in the former. The leaves are comparatively longer, averaging six centimeters long and three broad, oblong or obovate, gradually narrowing to the base, not rounded and cordate; the veins more distinct, though quite as thin, and the surface flat not inflated. In the former species the leaflets are marked in the middle by a depression like an effaced costa, which is not apparent upon those of this species. The differences are, perhaps, not marked enough to authorize a separation.

Habitat—Same as the former; nodules of Mazon creek.

§ 3. EUNEUROPTERIDS.

NEUROPTERIS HIRSUTA, *Lesqx., Pl. VIII, Figs. 1, 4, 5, 7, 9, 12.*

Boston Journ. S. N. H., Vol. VI, p. 417. Geol. of Penn'a, 1858, p. 857, Pl. III, f. 6, Pl. IV, f. 1–16. Geol. Rept. of Ill., II, p. 427; IV, p. 380. Schp., Paleont. Veget., I, p. 445.

Frond bi, tripinnate; primary pinnæ very large, secondary divisions alternate, oblique, lanceolate; ultimate pinnæ trifoliate in the lower part of the branches; becoming simple in the upper part; middle leaflets large, lanceolate, obtuse, entire or undulate; cordate and sessile to the rachis when simple; pedicellate when compound or bearing one or two small round or oval leaflets at the base; lower surface hairy; costa distinct, strong, and ascending to three fourths of the laminæ in the middle pinnules only; veins dichotomous, arched, thin and close, flabellate from the base in the lateral or basilar leaflets, with rarely a trace of a mid-rib.

This species is most polymorphous, not merely by the enlarging of the pinnules into cyclopterid leaves, extremely variable in form, generally round, unequilateral, sometimes with the point of attachment on one side; but especially by the multiplication and subdivisions of the small basilar leaflets, which, generally simple round or oval reniform in shape, become double in preserving the oval form of each division, or lanceolate, or variously cut into two or more linear obtuse lobes, and digitate as in f. 8. The medial leaflets of this species are sometimes broader at the base, and shorter, truncate, more rapidly narrowed upwards, but never pointed. The venation is close; the veinlets average forty to fifty per centimeter on the borders, and are indistinct, or buried in the epidermis, which becomes inflated between them. The terminal pinnules, as seen, f. 4, are lanceolate, obtuse, either entire or with a short obtuse lobe in the middle. The under face of the leaves is always supplied with rigid hairs one to three millimeters long, sometimes few, scattered here and there, and indistinctly seen, more generally numerous, close, and perceptible with the naked eyes. The cyclopterid divisions, at least the large ones, are often smooth.

Except the villosity, the characters of this species are much like those of the following, and in some cases it is very difficult to ascertain the reference of the leaflets generally found detached from the rachis, and often mixed together. The main rachis deprived of the leaflets, f. 12, is cylindrical, minutely lineate. It often bears the remains of the basilar support of the pinnules, broad at the base, triangular acuminate, resembling short spines. Sometimes, but rarely, as in f. 5, part of the short basilar pedicel remains attached to the leaflets.

It is probably upon one leaf of this kind that Brongniart made his species, *N. Scheuchzeri*, Hist. d. Veg. foss., p. 230, Pl. LXIII, f. 5. The characters are exactly those of *N. angustifolia*, a species commonly found at Wilkesbarre, wherefrom the author received the American specimen which he refers to it.

Habitat—Most of the coal beds from the base to the upper part of the middle coal measures. Extremely abundant at the Pittsburgh coal, the Salem vein, etc., and there sometimes mixed with the following; less predominant in the low coal of Ill., Morris; very rare at Mazon Creek, where it is superseded by *N. decipiens*. I have never seen it from the sub-conglomerate measures.

NEUROPTERIS ANGUSTIFOLIA, *Brgt.—Pl. VIII, Figs. 2, 3, 6, 8, 10, 11.*

Brgt., Hist. d. veg. foss., p. 231, Pl. LXIV, f. 3, 4.

N. aeutifolia? Brgt., ibid., p. 231, Pl. LXIV, f. 6, 7. Ett., Fl. v. Radnitz, p. 32, Pl. XVIII, f. 5. Gein., Verst., p. 22, Pl. XXVII, f. 8.

Schp., Paleont. Veget., I, p. 433.

N. eordata, Bunb'y, Fl. of Cape Breton, Pl. XXI.

N. heterophylla, Lesqx., Geol. of Penn'a, 1858, p. 859.

Primary pinnæ dichotomous, alternately forking in branches of a thick rachis; pinnæ very long, in a broad angle of divergence; pinnules simple or trifoliate, the medial ones linear-lanceolate, obtuse, the basilar, small, reniform or oval; venation same as in the former species.

The two pinnules figured by Brongniart as *N. angusti-*

folia, have the apex broken; but the shape is so exactly similar to that of a large number of leaflets observed in the Am. coal measures that it is scarcely possible to doubt their identity. Those representing *N. acutifolia*, also figured by Brongniart, are quite as numerous. The first are represented by f. 6, the others by f. 2, of our plate.

A very large specimen of this species in the Cabinet of Mr. S. S. Strong, of Morris, represents part of a bipinnate frond more than thirty centimeters long, rather dichotomous than pinnately divided; for the rachis, half a centimeter broad, has the lateral branches of the same size, by the forking of the main axis. The pinnæ are seven and a half centimeters distant, open and very long; none, however, is preserved whole. The longest part, the upper one, is fifteen centimeters. It bears distant alternate pinnules, rarely simple, more generally trifoliate, each of these composed, as in the former species, of a large medial pinnule and of one, more generally two basilar ones. The average size of the terminal leaflets is six centimeters long, longer in the middle of the pinnæ, shorter and smaller towards the base, one and a half to two centimeters broad, all linear-lanceolate, obtuse, of the same form as in Atl., f. 2, 3, 6. The basilar leaflets are small, oval or reniform, often enlarged laterally, all with the veins closer than in *N. hirsuta*. The leaflets are all smooth, without trace of hair. The main rachis bears also between the pinnæ some pinnules generally simple and shorter. Therefore we have here the same kind of ramification and disposition of pinnules as in *N. auriculata* and *N. Clarksoni*, a disposition recognized also in *N. Desorii* and *N. Loschii*, as seen for this last species from the beautiful specimen figured by Roehl, Paleont., XVIII, p. 37, Pl. XVII, which shows not only the divisions of the fronds, but also the relative position of the cyclopterid leaflets. It is, therefore, presumable that all the species of *Neuropteris* have an analogous mode of branching and bear in the lower part of the fronds cyclopterid pinnules, either sessile upon the main rachis by a narrowed point of attachment, or placed at the forks and surrounding the base of the branches as in

N. rarinervis, when they become enlarged and auricled around their supports.

I remarked in my description of *N. angustifolia*, Geol. Rept. of Ill., IV, p. 468, that I had received from Mr. Strong, of Morris, a splendid fragment, in a concretion from Mazon Creek, representing the top of a pinna of *N. hursuta*, in the process of unfolding or still curved in spiral, whose leaflets, very hairy on the lower side, are narrow, linear lanceolate, and equal at the base, like pinnules of *N. angustifolia.* This might provoke a doubt on the value of this last species. But as it has never been found represented with leaflets bearing hairs when fully developed, the characters taken from the shape of the pinnules when not yet quite opened are not reliable, and this unfolding pinna is, therefore, referable to *N. hirsuta.* The specimen is, however, very valuable as proving the true reference of the Genus *Neuropteris* to Ferns, a reference put in question by some authors.

Habitat—Found like the former in the whole thickness of the middle coal measures, but more abundant at the base; Cannelton, Morris, and Clinton; also at the Salem, Gate, and Mammoth veins of the anthracite. Not seen in the sub-carboniferous.

NEUROPTERIS CORDATA, *Brgt.*

Hist. d. veg. foss., p. 229, Pl. LXIV, f. 5. Ll. and Hutt, Foss. fl., I, Pl. XLI. Schp. Paleont. Veget., I, p. 432. Grd. 'Ey, Fl. carb., p. 119.

Pinnules (ultimate pinnæ) large, short-pedicellate, deeply cordate at base, oblong, acuminate; borders slightly undulate; medial nerve immersed, dissolved from the middle; veins curved in diverging to the borders, repeatedly dichotomous.

The above description is that of Schimper. That of Brongniart is less explicit and his species is represented by the figure of a single leaflet, a terminal one. Lindley and Hutton describe the large pinnules as oblong, cordate at base, acute at the apex, with perfectly entire margin and without any other midrib than what is produced by the united base of the veins. The English authors, however, represent, with the large leaves, a number of small, reniform or circular leaflets, scattered upon the same piece of shale, which they presume referable to the same species as basal leaflets of one of the pinnate divisions of the leaves. The numerous specimens found in the Am. coal measures, representing *N. hirsuta*, *N. angustifolia* and *N. decipiens*, some of them figured in the Atlas have exposed the peculiar characters of this group of Ferns, all bearing trifoliate pinnæ, with deciduous pinnules rarely found attached to the rachis. This however does not afford any light on the identification of that *N. cordata*. I have always been and am still uncertain in regard to the true characters of this species. It seems to be a variety of *N. angustifolia*, from which it differs essentially by the broader terminal leaflets. For, this last species is generally represented in the same localities by both, narrow pinnules, like those of Pl. VIII, f. 2 and 6, mixed with broader ones corresponding in shape to Brongniart's and Ll. and Hutt. figures of *N. cordata*. The venation of all these leaves is exactly the same, but none answer to some of the characters indicated by the European authors who say, of the pinnules, that they are acute, and of the costa, that it is very thin (Brgt.), or according to Ll. and Hutt., that it is no other than what is produced by the united base of the veins. In the American specimens the top of the pinnules is more or less obtuse, or sometimes obtusely acuminate, and the costa is always distinct, rather broad and flat to above the middle.

In all the species of this group, the basilar pedicels remain sometimes attached to the terminal pinnules as a continuation of the costa. It is probably from one leaf of this kind that is made *N. Scheuchzeri*, Brgt., l. c., p. 230, Pl. LXIII, f. 5. The characters of this species are in concordance with those of the leaflets of *N. angustifolia*, which sometimes pedicellate and rounded at the base, are, as the author says, neither truncate nor cordate (Atlas Pl. VIII, f. 2). The American specimens referred to *N. cordata* by Brongniart, are from Wilkesbarre, where both *N. hirsuta* and *N. angustifolia* are common.

Habitat—Same as *N. angustifolia*.

NEUROPTERIS DECIPIENS, *Sp. nov.*

Fronds pinnate; ultimate pinnæ simple or trifoliate; leaflets large, of thick texture, the middle ones oblong, more or less gradually narrowed to an obtuse apex, cordate at the base, hairy; costa strong, continuous to near the apex; veins dichotomous, curved, distinct, somewhat distant.

The leaflets referable to this species resemble by their form and size the largest of those of *N. hirsuta.* The difference is in the still larger size of the middle pinnules, more rapidly narrowed to a more acute point, and especially in the more distant and distinct veins. The costa is a little more enlarged towards the base and the pedicel, often attached to it, is broader. However it would be impossible to separate the species without closely considering the lateral veins which, thin and more distinct, are nearly twice as distant. In counting the veins along the borders, in a given space, and upon a large number of specimens of as equal size as possible, they average, as seen above, forty per centimeter on leaflets of *Neuropteris hirsuta* and only twenty-eight on those of this species. The hairs are generally strong and closely spread on the lower surface.

Habitat—Nodules of Mazon Creek where specimens of *N. hirsuta* are rare. I have also a few specimens of this species from the shale of Centralia Coal shaft, Ill.

NEUROPTERIS FASCICULATA, *Lesqx., Pl. XXIV, Figs. 5, 6.*

Geol. Rept. of Ill., IV, p. 381, Pl. V, f. 1-4. Schp., Paleont. Veget., III, p. 472.

Bipinnate; leaflets of medium size, entire, cordate or oblong, acute or acuminate; surface smooth; midrib thin, continued to the point, veins thin, somewhat distant, dichotomous and arched.

I have not seen of this species any pinna, but merely detached leaflets, and mostly terminal ones, generally fasciculate by the sub-division of the pedicel. The pinnules, five to nine centimeters long, one and a half to four centimeters broad, are oblong, either tapering to a point, or abruptly contracted to an acumen, as in f. 5. The acuminate apex already separates this species from the former. The midrib is narrow, rather thin, but perceptible to near the point of the leaflets; the veins are about at the same distance as in *N. decipiens*, twenty-five in one centimeter, on the borders. The texture is thin, the leaflets sometimes split in the middle.

The peculiar subdivisions of the rachis, as seen, f. 6, might be taken as casual, and therefore considered of no value as a character. I have however seen very few simple leaflets of this species, while a number of others present this peculiar mode of division as may be seen in three figures, 1, 2, 3, of the Geol. Rept. of Ill. quoted above. It would seem therefore that we have here some late and modified representative of a remarkable type of Ferns of the sub-carboniferous seen upon the same plate in *Megalopteris fasciculata*, f. 2, whose nervation is intermediate to *Neuropteris* and *Alethopteris* and whose rachis is similarly subdivided as support of the upper pinnules. The species are figured upon the same plate for comparison.

Habitat—Mazon creek, in nodules; Neleysville, Ill., first coal above the conglomerate.

NEUROPTERIS CLARKSONI, *Lesqx., Pl. IX, Figs. 1–6.*

Boston Journ. S. N. H., v. VI, p. 417. Geol. of Penn'a, 1858, p. 857, Pl. VI, f. 1–4. Geol. Rept. of Ill., II, p. 428. Schp., Paleont. Veget., 1, p. 446.

Frond tripinnate; primary rachis very large, dichotomous; pinnæ open, long, lanceolate or linear-lanceolate; pinnules simple, variable in shape from broadly triangular, reniform, obtusely or acutely pointed, to lanceolate and linear-lanceolate; costa thick, ascending to above the middle; veins strong, distant, curved, dichotomous.

The multiple forms of this species would render identification of the leaflets a very difficult task, if its venation was not of a distinct character. The cyclopterid leaflets are broadly triangular, with generally a long auricle or lobe on one side, which often bears a midrib, as well as the primary part of the lamina. As in *N. angustifolia*, the main rachis supports scattered leaflets of different size, f. 2, sometimes very large. The terminal leaflets are lance-shaped, deeply undulate on the borders, or cut in one or two irregular lobes on each side. The venation is very strongly marked, always clear and distinct, the middle nerve thick, especially at the base, abruptly dividing above the middle, and the veins, in an acute angle of divergence, moderately curved, generally twice forked, are thicker toward the point of attachment.

This species has in its size, in the divisions of the fronds, in the form of the leaflets, variable according to their position either upon the main rachis, or upon its branches, a very intimate relation to *N. auriculata*, a species common in the European coal measures. The great difference in the character of the nervation is, however, easily ascertained, and sufficient to separate them.

Mr. R. D. Lacoe, of Pittston, has in his cabinet a large slab covered with fragments of this Fern, especially part of a frond, fifty centimeters long, with the upper pinnæ dichotomous or exactly forking, twenty-five centimeters long. The pinnæ are separated by pinnules generally large and triangular, attached to the main rachis. On the lower pinnæ the inferior leaflets become larger, triangular, either broadly and deeply cordate or auricled; or even some ones are narrowed nearly abruptly, as if they were attached by the corner of a triangle. This specimen has a large number of pinnules, bearing the supposed fructification of *Neuropteris*.

Habitat—This species is locally very abundant; for example, in the north of the Pennsylvania anthracite basin, Oliphant, Wilkesbarre, Pittston, Carbondale. It is, per contra, very rare in the Western coal basin. From Missouri I have received only one separate pinnule which seems to be referable to it. The specimen is in bad state of preservation. Mazon creek has it in separate pinnules, well preserved in nodules. In Ohio I have not seen it. It has been collected in fine and numerous specimens at Cannelton, Pa., by Mr. I. F. Mansfield.

NEUROPTERIS PLICATA, *Sternb.,—Pl. X, Figs. 1–4.*

St. Vers., II, p. 74, Pl. XIX, f. 1–3. Brgt., Hist. d. Veg. foss., p. 248. Neuropteris flexuosa, Lesqx. Geol. of Penn'a, 1858, p. 852–857.

Frond bi, polypinnate; rachis thick, round, striate; pinnæ linear, lanceolate to the apex; pinnules open or in right angle, disjoined, oblong, obtuse, entire, flexuous on the borders, sessile or short pedicellate; terminal pinnules lanceolate, obtusely acuminate, lobed on one side; veins thin and close, dichotomous, curving to the borders from a thin middle vein, effaced near the point.

It is very difficult to separate from the descriptions and figures of the authors, and without specimens for comparison, some species of this group, especially this one from *N. flexuosa.* The description of *N. plicata*, by Sternberg, agree with the character of the plant figured here, which, in some of its forms, has the borders more distinctly undulate-plicate than seen upon the figures. The author describes the thin midrib, the very close, thin lateral veins, and the lanceolate terminal pinnule, which, from his figure, has the same form as that upon our specimens. Brongniart, Gœppert, and Unger, have merely repeated the author's description, and Schimper does not even mention the species.

On another side, of *N. flexuosa*, to which I was disposed to refer those specimen, Brongniart figures only one leaflet and a fragment of a pinna whose terminal pinnule is broken, and particularly remarks in the description that the leaflets are close and always imbricated along the borders. Schimper says of the same species that the primary nerve is indistinct, and dissolved near the base. Both these characters are at variance with what is seen upon the American plant, as also the character which gives the name to the species, the flexuous rachis. A terminal pinnule of *N. flexuosa*, with the same form as that of f. 2, of our plate, is given by Gutbier, Abdr., Pl. VII, f. 1 and 1*a*; but the lateral leaflets are shorter without trace of a midrib, and thus far different from the characters indicated by Sternberg's description. I cannot, indeed, recognize in any

American specimens the true *N. flexuosa*, Brgt., for, by comparison, I find the characters of *N. plicata*, especially a thin, distinct midrib in those which I formerly referred to this species in Geol. of Penn'a, l. c.—*N. Leberti*, Heer, Fl. foss. Helv., p. 22, Pl. II, f. 8–10, seems really referable to Sternberg's species. Per contra, *N. plicata*, as figured by Roehl, foss. fl., Pl. XIII, f. 8, with leaflets veined in right angle to the midrib, and Pl. XX, f. 7, is far different from the plants which I refer to it.

Habitat—Especially found in the upper part of the middle coal measures. It abounds at Pomeroy, also in the Pittsburgh coal. Numerous specimens have been sent by Prof. I. C. White, from a vein of coal four hundred feet above the Waynesburg coal. Seen also, but rarely, at Cannelton, and in the nodules of Mazon creek. Sent by Prof. Worthen, from an upper coal of Fayette county, Ill.

NEUROPTERIS ROTUNDIFOLIA? *Brgt.—Pl. XIII, Fig. 8.*

Brgt., Hist. d. Veg. foss., p. 238, Pl. LXX, f. 1. Gutb., Abdr., p. 56, Pl. VII, f. 3, 4. Lesqx. Geol. Rept. of Ill., II, p. 428. Schp., Paleont. Veget., I, p. 441.

Bipinnate; pinnules sub-opposite, imbricating on the borders, short, broad, very obtuse, rather enlarging at the top, sessile; costa distinct at the base; veins thin but distinct, close, dichotomous, arched in passing to the borders.

The only fragment in my possession may be too imperfect to afford satisfactory evidence for identification. Comparing it, as it is, to the one quite as fragmentary, figured by Brongniart, under this name, no difference whatever is appreciable. The leaflets are in the same position, in right angle on one side of the pinnæ, obliquely placed on the other; the nervation is of the same character. The author supposed that his specimen might represent a variety of *N. flexuosa*. By the close venation of the pinnules, it rather resembles an enlarged form of *N. Loschii*, while it is identified by Geinitz to *N. auriculata*. The fragment represented by Gutbier, l. c., though too small, agrees well enough in its characters with the figures and description of the species. But the pinnules referred to it by Roehl, foss., fl., p. 35, Pl. XII, f. 4*b*, are mere basilar leaflets of *N. angustifolia*, or *N. cordata*.

Habitat—The specimen figured here is from Gate or Salem Vein, near Pottsville. Another specimen of the same character in the State Cabinet of Ill., is from Grayville, a high coal like the former.

NEUROPTERIS LOSCHII, *Brgt., Pl. XI, Figs. 1–4.*

Brgt., Hist. d. Veg. foss., p. 242, Pl. LXXIII and LXXII, f. 1. Gutb., Abdr., p. 55, Pl. VIII, f. 6. Roehl, Foss. fl., p. 37, Pl. XVII (splendid specimen). Lesqx., Geol. of Penn'a, 1858, p. 858. Geol. Rept. of Ill., II, p. 428. Schp., Paleont. veget., I, p. 437. Heer, Fl. foss., Helv., IV, p. 23, Pl. III, f. 6–8.

Gleichenites neuropteroides, Goepp., Syst., p. 186, Pl. IV and V.

Frond pinnately dichotomous; pinnæ open, linear, slightly narrowed to an obtuse terminal pinnule; pinnules oblong, sub-cordate, very obtuse, more or less enlarged on the lower side of the base, sessile; costa distinct near the base, effacing above; veins thin, close, dichotomous.

The species, as far as it is known from American specimens, has generally small pinnules, variable in size from one half to two centimeters long and four to ten millimeters broad. They very gradually shorten from the base of the pinnæ to the apex. The lower basilar leaflet only of each pinna is longer, enlarging at the apex, even unequilateral and attached by one side as seen at the base of the lower pinna, f. 1. These dimorphous leaflets explain the characters of the unequilateral large leaves described by Brongniart as *Cyclopteris obliqua*. The terminal pinnule is oval, obtuse, unequilateral in the middle, or more enlarged on one side. In the upper part of the primary pinnæ, as seen, f. 4, the secondary ones becoming shorter, pass gradually to simple pinnules by the diminution in size and number and the cohesion of the lateral leaflets. The veins are thin, close but distinct, slightly thicker towards the base, where they unite to a midrib more generally marked by a depression which is effaced above the middle as seen f. 3.

Sometimes the lateral veins become undulate and united in oval meshes, as in species of *Dictyopteris*. One specimen from Cannelton has this variety very clearly marked upon a bipinnate branch of which all the leaflets are true *Neuropteris* by their dichotomous veins, while a single one, at the base of a pinna, has distinctly the venation of *Dictyopteris*. The mode of branching of this species is seen on the splendid specimen figured by Roehl, l. c., with cyclopterid pinnules attached to the broad rachis, as remarked already.

A detached leaflet of *Cyclopteris* of this species is observable upon the specimen f. 1. It is equilateral and slightly undulate on the borders. Others are generally found upon the shale bearing remains of this fine Fern. They are cordate or auriculate, equilateral or unequilateral. Roehl refers these leaflets to *C. trichomanoides*, Brgt., a reference contradicted by the too great distance of the veins on the borders.

This species closely resembles by the form of its leaflets *N. tenuifolia*, which however always differs by more distant secondary veins and by the terminal leaflet lanceolate.

Habitat—From the base, to the highest beds of the middle coal measures, passing above into permo-carboniferous beds. I have found it in beautiful specimens in the red clay beds of Marietta, higher than the Pomeroy coal, generally associated with *Pecopteris arborescens*. Abounds in the horizon of the Pittsburg coal in Ohio; not rare in the nodules of Mazon Creek; also at Cannelton, Pa., and Clinton, Mo. It is one of the finest, most common and most distinctly characterized species of the group.

NEUROPTERIS VERMICULARIS, *Lesqx.*, *Pl. X*, *Figs. 5–10.*

Lesqx., D. Owens, Geol. Rept. of Ky., IV, p. 434. Geol. Rept. of Ill., II, p. 428; IV, p. 385, Pl. VI, f. 1–3. Schp. Paleont. veget., IV, p. 474.

Pinnately divided; pinnæ linear, slightly narrowing upwards to a deltoid or oblong, obtuse terminal pinnule; lateral leaflets open, mostly in right angle, oblong, obtuse, sub-cordate, rounded or truncate at the base, with the inferior lobe slightly prolonged; midrib broad near the base, distinct to the middle; lateral veins forking two or three times, distinct, irregularly inflated, moderately curving in passing to the borders.

The species has been observed in many specimens, all fragmentary, representing mere simple pinnæ, and these not even entire, except one lately sent by Prof. Worthen. In all these specimens, the characters, as represented upon the plate, the peculiar form of the terminal pinnules and the venation are the same. The leaflets appear to have been of soft texture, with a thick epidermis, as the veins are sometimes immersed into it. More generally, the surface seems partly destroyed by maceration and the thread-like veins then exposed and salient, separate easily in fragments, looking like broken parcels of rain worms. The pinnules, close, contiguous by the borders and oblique in the upper part of the pinnæ, are in right angle and distant in the lower part. They vary in size from three millimeters long, f. 9, to four centimeters, f. 7. Sometimes in specimens unaltered by maceration, the veins are visible only per place or pierce the epidermis by their sharp, cylindrical, hard texture. But, even upon one and the same specimen, a fragmentary deterioration of the surface expose them distinctly or detached in fragments. The rachis is half round, striate in the middle, smooth and flat on the borders.

Habitat—Roof shale of the lower coal 1, of Ky. Nodules of Mazon creek, and shale of Morris coal. I have from Cannelton a single leaflet apparently referable to this species.

Neuropteris tenuifolia, *Brgt.—Pl. XII, Figs. (1?) 2–9.*

Brgt., Hist. d. Veg. foss., p. 241, Pl. LXXII, f. 3. Goepp., Syst., p. 197. Lesqx., Geol. of Penn'a, 1858, p. 858. Geol. Rept. of Arks., II, p. 312, Pl. V, f. 2–6. Geol. Rept. of Ills., II, p. 428. Schp., Paleont. Veget., I, p. 430.

Cyclopteris elegans, Lesqx., Boston, Journ. S. N. H., VI, p. 416. Geol. of Penn'a, 1858, p. 856, Pl. V, f. 4.

N. flexuosa, var. tenuifolia, Heer, Fl. foss. Helv., IV, p. 21, Pl. III, f. 4, 5.

Leaf bipinnate; pinnæ small, sub-linear; pinnules variable in direction, open or oblique, close or distant, alternate, oblong, either obtuse or narrowing to an obtuse apex, cordate or more generally rounded and equilateral at the base; costa thick, dividing above the middle; veins clearly marked, though thin, inflated towards the base, forking twice or more in the large leaflets.

Though I consider this form as positively representing

Brongniart's species, there is still in the characters of our leaves some deviation from the European type. The lateral leaflets are either narrowed to an obtuse point, but quite as often oblong, obtuse, not generally close and imbricating along the borders, but often separated even distant. The terminal pinnule, however, is always lanceolate, comparatively long, and obtusely acuminate, exactly as it is figured by the author, and also the midrib is thick and well marked to above the middle. Brongniart says of the veins, that they are close and very thin. Though very thin, a character which separates this species from the former, they are always distinct and more distant than in *N. Loschii.* F. 8 and 9, Atl., represent the cyclopterid pinnules of this species, always unequilateral, one of the sides being generally prolonged into a long auricle, while the other is rounded. This disposition is already remarked in the lower leaflets of the branch f. 4, rounded on the upper side and extending to an acuminate lobe on the other.

Fig. 1, is doubtfully referred to this species. The pinnæ are very long, not open, but curved inward; the pinnules, contracted in the middle, are equilateral and rounded at the base. At first I considered the specimen as referable to *N. gigantea*, St., but there is a great difference in the shape of the pinnules, which, in the European species, are oblong, oval, and evidently scythe-shaped. Neither the specimen on which Sternberg's species is made, nor this one, have any terminal leaflets, hence their form cannot be considered. The affinity is marked in the contraction of some pinnules in the middle, as in f. 1, clearly seen in f. 2 and 3, and in the distance between the leaflets which is the same; those of f. 5, also, are rounded to the base, and equilateral, as in f. 1. The venation is of the same character. There is a difference only in the length of the pinnæ and the form of the cylindrical rachis, which is rather smooth than striate.

Prof. Heer, l. c., considers this species as a mere variety of *N. flexuosa*, Brgt. If the plant described here is the true *N. tenuifolia*, Brgt., it is certainly different from *N. flexuosa* by the nervation, the size of the pinnules, the shape of the terminal leaflet, and the consistence of the texture. As said above, I am unable to recognize in the American specimens any fragment referable to *N. flexuosa*, or answering to the characters indicated by the author, and seen upon European specimens preserved in the cabinet of Dr. D. Owen. Per contra, *N. tenuifolia*, is one of the more common plants of the coal measures of this continent.

Habitat—The species follows about the same distribution as *N. Loschii*. It appears earlier, however, as I have found, in the sub-carboniferous coal of Arkansas, specimens still more positively referable to it than those figured in the Atlas. It is not rare in the low coal of Missouri, Illinois, Ohio, and Pennsylvania, and equally abundant in the upper anthracite beds.—Salem, Gate vein, etc.

NEUROPTERIS SUBFALCATA, *Sp. nov.*, *Pl. XIII, Figs. 5, 6.*

Bipinnate; pinnules in right angle to a narrow rachis, sub-opposite, oblong, obtuse, more or less distinctly sythe-shaped, sub-cordate, and equilateral at the base, contiguous, imbricated on the borders, or distant; costa narrow, discernible to near the apex; veins close, distinct, scarcely inflated, curving in passing to the borders, forking two or three times.

Besides the fragments figured, I have seen still two other parts of pinnæ, with smaller pinnules of the same characters. The leaflets vary from one to three and a half centimeters long, and from four to twelve millimeters broad. They are all more or less curved upwards, (scythe-shaped,) rounded or sub-cordate and equilateral at the base, either sessile or short pedicelled, generally close and imbricate, the specimen, f. 6, being the only one with distant pinnules. The venation is close, more distinct, and slightly more distant than in *N. Loschii*.

Except that the leaflets are imbricate and the midrib distinct, not immersed, these fragments might be still more than the one of Alt., Pl. 12, f. 1, considered as representing *N. gigantea*, St. The form of the leaflets of

f. 5 is the same, the ultimate rachis quite slender, the veins very close; therefore, the essential characters correspond with those of the European species. For Geinitz, Verst., p. 22, Pl. XXVIII, f. 1, describes and figures it with a distinct midrib. All the authors, however, admit as essential characters the great distance of the pinnules. I cannot, therefore, decide on the specific identity. It is, however, supposable that there may be a difference of relative position of the leaflets in some pinnæ of a Fern which appear to have had a very large frond. Heer, Fl. foss. Helv., p. 22, Pl. VI, f. 22, has a species, *N. montana*, which seems to differ from the American form, merely by narrower leaflets.

Habitat—Sub-conglomerate coal measures. Montevallo coal mines, Ala., locality indicated by Mr. T. H. Aldrich for the specimens not figured. The others sent by Prof. E. A. Smith, without labels, are upon gray shale of the same matter as those from the Helena coal.

NEUROPTERIS CAPITATA, *Lesqx., Pl. XXIII, Figs. 1–3.*

Geol. Rept. of Ill., IV, p. 383, Pl. VII, f. 1. Schp. Paleont. Veget., III, p. 473.

Leaf bi-tripinnate; primary pinnæ triangular in outline; secondary, divisions open, linear; pinnules close short, oblong, very obtuse or half round, joined to the rachis by a short broad pedicel; terminal pinnules very large, deltoid, obtusely acuminate; costa none; veins very thin and close, dichotomous moderately curved.

This species is distinctly characterized by the peculiar form of the terminal leaflets, and the comparatively small size of the lateral pinnules which measure only about one third of its length. They are alternate or sub-opposite, truncate at the base, with the inferior lobe more or less distinct and prolonged. The veins sometimes come out of the enlarged point of attachment, wherefrom they diverge fan like. By this character, the species is related to the section of the Nephropterids. Often however, the pinnules bear traces of a basilar midrib, which in some leaflets is marked to near the middle. The lateral pinnules of f. 2, show the venation straight from the enlarged base, similar to that of species of *Odontopteris.* But this enlarging of the base of the upper leaflets which become decurrent, is remarked on other species of the genus, especially in *N. tenuifolia.* F. 3 is very probably one of those pinnules of peculiar form, attached to the main rachis, like those of *N. Clarksoni*, seen Atl., Pl. 9, f. 2. The veins are as close as in *N. Loschii;* the texture of the leaflet is rather thin.

Habitat—Lower coal measures of Illinois; nodules of Mazon Creek, and roof shale of Murphysborough Coal. Represented at Cannelton by some specimens, with leaflets like f. 2, 3, and by cyclopterid leaves described as *N. trichomanoides?* This species is very rare.

NEUROPTERIS MISSOURIENSIS, *Sp. nov., Pl. VII, Figs. 5, 6.*

Pinnately divided. Rachis thick, striate; pinnæ short, linear, in right angle; lateral pinnules oval, obtuse, round or truncate at the base, sessile; terminal leaflets very large, oblong or ovate, obtuse; midrib distinct; veins forking twice, curved to the borders.

By the large size of the terminal leaflets, compared to that of the lateral pinnules, this species resembles the former. It is clearly distinct not merely by the shape of the leaflets, the lateral ones rounded at the base, sessile, the terminal oblong, obtuse, but also by the nervation. The midrib is very distinct and prolonged; and the veins not half as close and numerous. They are thin and thus intermediate in characters between those of *N. Loschii* and *N. rarinervis.* The imbricated lateral leaflets of f. 5 are by form and relative position exactly like those of *N. rotundifolia.* But in this last species the pinnules have no distinct midrib and a more compact venation.

Habitat—Clinton, Mo. Communicated by Dr. John H. Britts, in three specimens.

NEUROPTERIS GRANGERI, *Brgt., Pl. XIII, Fig. 9.*

Brgt., Hist. d. Veg., foss., p. 237 Pl. LXVIII, f. 1. Schp., Paleont. Veget., 1, p. 441.

Neuropteris Cistii, Brgt., Hist. d. Veg. foss., p. 238, Pl. LXX, f. 3. Schp., Paleont. Veget., 1, p. 441.

Bipinnate; pinnæ long, alternate, very open; pinnules close or distant, alternate, oblong, obtuse, dilated near the base, sub-pedicellate; midrib indistinct, immersed; veins distinct and distant, moderately curved, forking twice.

By the addition of the modified character on the relative position of the leaflets, *close or distant*, the above diagnosis describes both *N. Grangeri* and *N. Cistii.* Brongniart already supposed that these two species might be the same, and Schimper who examined the specimens is of the same opinion. Though this Fern is rare, I have seen a number of specimens, most of them now in the museum of Comp. Zool. of Cambridge. They clearly represent one species only, the characters of both being observable even upon a same specimen. The difference in the distance of the pinnules is remarked already upon Brgt's figure of *N. Grangeri*, l. c., those of the lower pinnæ being close and contiguous, while those of the upper are more or less distant. Pl. LXX of Brgt., l. c., represents a branch with still more distant leaflets, similar to that of Atl., f. 9. The other characters are common to both. Generally the pinnules are enlarged near the base or rounded to a flat short-pedicel; sometimes rounded or subcordate and sessile, they become slightly narrower to the obtuse point and vary in size from eight to eighteen millimeters long and from five to twelve millimeters broad, near the base, where they are the widest. The nervation is the same in both; a midrib, indistinct by immersion into the parenchyma, marked from the base to above the middle by a depression; and lateral veins sharply cut, generally forking twice, thus somewhat distant, moderately curving in passing to the borders.

Schimper quotes as referable to this species *Adiantites* (*Cyclopteris*) *heterophyllus*, Goepp. Syst., p. 222, Pl. XXXV, f. 1., 2. From the description of the author who characterizes the form of the pinnules as sub-orbicular, the upper ones obovate, decurring, and the veins very numerous (*creberrimis*), it cannot be identified with Brgt's. species, which seems until now exclusively American.

Habitat—Prof. Brongniart received the specimens of *N. Grangeri* from Zanesville, and those of *N. Cistii* from Wilkesbarre. My own specimens in the collection of the Museum of Cambridge are from Salem and Gate Veins, near Pottsville; the specimen figured here is from New Philadelphia, an upper coal of the same horizon. But I have found it also at the lowest vein of the Shenandoah basin, under the mammoth and seen a fine specimen of it obtained from the Raush Creek vein, the equivalent of the Mammoth, by Mr. Wetherell of Tremont. This shows the vertical distribution of the species to be a wide one. It is generally very rare and until now obtained in fragments of small dimensions. I have not seen any pinnæ as large as the one figured by Brongniart. The species is allied to *N. Losehii* by the form and size of the leaflets and to *N. tenuifolia* by the venation.

§ . PACHYDERMATE.

NEUROPTERIS SMITHSII, *Lesqx.*, *Pl. XIII, Figs. 1–3.*

Geol. Rept. of Ala., 1876, p. 76.

Frond polypinnate, apparently large; primary divisions lanceolate, open from a broad, striate rachis; ultimate pinnæ in right angle to a narrow rachis, linear, lanceolate to the apex; pinnules distant, small, broadly oval, or nearly round, sub-truncate or sub-cordate at the base; terminal pinnule large, oblong or broadly ovate; middle nerve distinct to near the point, deeply impressed into the thick epidermis; lateral veins sharply marked, curved back to the borders which they reach in right angle, forking once at the middle, sometimes once more from the very base.

This fine very distinct species had apparently a frond of large size. Though I have mostly small fragments of it like those figured, its leaflets with broken parts of rachis are spread upon the whole surface of large specimens. It is at once recognized by its small, oval or round thick leaflets, the terminal pinnules comparatively large, the deep midrib, and the sharply salient veins.

I do not know any European species closely allied to this. *N. microphylla*, Brgt., has leaflets of about the same size. But they are obtusely lanceolate, and according to the description of the author, the veins are indistinct. *N. Lindleyana*, St., has small leaflets and salient veins, at least as seen by the figures in Ll. and Hutt., Foss. fl., Pl. XLIX, under the name of *N. Loschii.* But neither by the shape of the pinnules, especially of the terminal one, nor by their position on the rachis, can it be compared to this.

Habitat—Black Creek vein, New Castle coal, Ala., very abundant. Splendid specimens have been sent me from that locality by superintendent Thos. Sharp, and later by T. H. Aldrich. I saw it first in the collection of Prof. Eug. A. Smith. The species has been discovered also in Virginia at the Quinnimont Coal by Prof. Wm. H. Fontaine,* there associated, as in Alabama, with *Sphenopteris Hoeninghausi* and other sub-conglomerate forms.

NEUROPTERIS ELRODI, *Sp. nov.*, *Pl. XIII, Fig. 4.*

Pinnæ large; rachis smooth; divisions in right angle; ultimate pinnæ linear-lanceolate; pinnules small, lanceolate, obtusely acuminate; nervation and texture of the leaflets same as in the former species.

Possibly this form may be a variety of *N. Smithsii.* The shape of the pinnules is however far different and as I have received most of its specimens from Indiana, without any leaflets like those of the former, its separation appears really legitimate. The rachis is smooth, not striate and the pinnules lanceolate and still more distant. These are the only characters which may be rcorded as peculiar to it. It is closely related to *Neuropteris Dluhoschi*, Stur, Culm Flora, p. 183, Pl. XI, f. 9, whose leaflets of the same shape are still longer. The deep midrib is prolonged to near the

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*Conglomerate series of West Virginia, Am. Journ. Sci., 3d series, May, 1866, p. 380, described as possibly a var. of *Neuropteris Lindleyana*, St.

point and the lateral veins reach the borders also at right angle. But the author describes them as very close, while in this species, they are comparatively distant.

Habitat—Montevallo seam, Ala., T. H. Aldrich. The specimen figured is in the Cabinet of the Alabama State Geol. Survey, without labels. Sent mostly from the Whetstone grit of Orange county, Ind., by Prof. E. T. Cox.

NEUROPTERIS OBSCURA, *Sp. nov.*

Bipinnate; rachis broad, obscurely striate; pinnæ open, close, alternate; pinnules variable in size and form, oblong, either very obtuse, even enlarged to the top, or longer, with both sides parallel, obtuse or narrowed to an obtuse apex, truncate at the base; venation obliterated by a thick hard epidermis; midrib inflated, effaced in the middle; veins obsolete when the epidermis is preserved, distinct under it, very close and numerous, scarcely arched, dichotomous.

The leaflets unite in their form and size the characters of both *N. Loschii* and *N. plicata;* they are, however, more variable in size, sometimes half round, sessile, broadly oblong, very obtuse, truncate at the base, with the lower lobe prolonged, and a terminal pinnule, short, obtuse, enlarged in the middle on one side, or oval, nearly equilateral, only more rapidly narrowed to the petiole on one side than on the other. On one of the specimens, the lateral leaflets measure less than one centimeter long, and are nearly as broad. On the reverse of the same, they are eighteen millimeters long, six millimeters broad, with parallel sides and obtuse apex, and upon another, the pinnules, two and a half centimeters long, eight millimeters broad at the base, are rounded to a short petiole, and lanceolate acuminate, exactly similar in shape to *N. acuminata*, Brgt., as figured by Ll. & Hutt., Foss. Fl. 1, Pl. LI. Separate leaflets present still other peculiar forms, one of them, apparently a cyclopterid pinnule, six centimeters long, is divided from a little above the unequilateral and oblique base in two lanceolate obtusely pointed and parallel lobes, each fourteen millimeters broad, and five centimeters long. The surface is a thin lamina of hardened coaly matter, opaque, or polished, through which the convex midrib is obscurely seen; the veins, however, are totally obscured. But when the epidermis is detached the venation is distinct. The lateral veins are very close, forking four or five times, numbering five per millimeter along the borders, only slightly arched and rough. All the parts of the plants are rigid. The main rachis is convex, obscurely lineate, as seen through the epidermis. The ultimate pinnæ are open, parallel, close, and the pinnules are either very close, imbricated on the borders, or more distant, with a narrow interval between them.

Until recently I had seen of this species only separate pinnules scattered upon pieces of shale of different localities. Though I recognized an evident affinity in the characters of these leaflets, especially in the nervation and the peculiar epidermis, I was unable to identify and determine them, on account of their very variable forms, and they have been therefore, left undescribed until now.

Habitat—St. Clairsville, Ohio, from a high coal, equivalent of the Pittsburgh bed. Mr. P. W. Emerson sent from that locality the specimens described above. The plate being engraved already, they could not be figured. I found the first pinnules of this species in a bed of hard shale, below Tamaqua, Penn'a. Later, some better ones, but still very fragmentary, were obtained from the Tunnel vein of Sharp mountain, below Tremont. This vein is the equivalent of the Salem vein, of Pottsville, wherefrom I had also a few scattered leaflets. A very rare species.

NEUROPTERIS RARINERVIS, *Bunb'y., Pl. XV, Figs. 2–5.*

Bunb'y., Coal form. of Cape Breton, Quat. Geol. Jour., III, p. 425, Pl. XXII. Lesqx., Geol. of Penn'a, 1858, p. 859. Geol. Rept. of Ill., II, p. 428, Pl. XXXIII, f. 1–5; Pl. XXXIV, f. 1; IV, p. 386, Pl. VIII, f. 1 to 6. Schp., Paleont. Veget., I, p. 440; III, p. 474.

Frond large, polypinnate; primary rachis thick; pinnæ broad, triangular in outline; ultimate pinnæ long, linear or linear-lanceolate; pinnules small, distant, alternate, *sessile, cordate at base, oblong, slightly or gradually narrowed upwards, obtuse; midrib enlarged at the base, dividing in the middle of the lamina; veins thick, distant, forking once or twice.*

The species though variable is easily recognized by the thick texture of its leaflets, the small cordate, or obscurely lobed pinnules, the terminal ones being comparatively long, lanceolate, obtuse, or blunt at the apex, generally lobed at the base. The veins are rather flat than thick, inflated on their borders by fascilles of vessels which, by maceration, become sometimes more divided or distant, the veins then appearing double. In order to show the relation of the cyclopterid pinnules by identity of the character of the veins, I have figured branches and leaflets of this species in Vol. 2, l. c., of the Geol. Rep. of Ill.; and in Vol. 4, I have represented a branch, Atl., f. 3, which shows in its natural position a cyclopterid pinnule on one side, and on the other, a pinna with leaflets of the common shape. I have since received from Morris, where the species abounds, large fragments of stems of this species, one measuring three and a half centimeters across, flattened, coarsely irregularly striate, covered with cyclopterid pinnules, seven to eight centimeters in diameter, nearly exactly round. They do not appear to embrace the stems but seem to be attached to one side of it by the central round point, the basilar auricles overlapping each other. Another specimen has these pinnules unequilateral with the lobes more prolonged one side as in those of the Geol. Rept. of Ill., II, Pl. XXXIII, f. 4 and 5, and others only cordate at the point of attachment, as f. 3, of the same plate. We may therefore follow them in a variety of contours and size which gives an idea of the dimension and the beauty of this Fern. The veins are in all these pinnules of the same character, distant, deeply impressed into the thick epidermis, which inflated in the intervals, appears ribbed or costate like the bark of *Calamites*. These leaflets seem to represent *Cyclopteris obicularis*, Brgt., and I should not doubt the identity if *N. rarinervis* had been found in the European Coal measures.

Habitat—Very common in the lower beds of the Western Coal Measures of Illinois, Murphysborough and Morris, especially; of Missouri, Clinton; also in a shaft near Ellsworth, Kansas. In Pennsylvania, it is especially abundant at Room Run mines, above Mauch Chunk. Specimens from Oliphant, No. 1 vein and from Wilkesbarre, Oakwood colliery F, are in the cabinet of Mr. R. D. Lacoe.

NEUROPTERIS CORIÀCEA, *Lesqx.*, *Pl. XVIII*, *Fig. 6.*

Geol. Rept. of Ill., IV, p. 387, Pl. VIII, f. 7, 8. Schp., Paleont. Veget. III, p. 475.

Pinnæ lanceolate; pinnules linear-lanceolate, obtusely acuminate, the lower ones long, obscurely lobed or deeply undulate toward the base; medial nerve thick, continuous; lateral veins curved, forking twice; substance thick, coriaceous.

Species intermediate between the former and the following one. The substance is very thick, the surface covered with a coating of coaly matter, through which the veins are obscurely seen. Under the epidermis, detached per fragments, the impression of the lateral veins, is distinct. They are distant, curved, forking generally twice. The venation is of the same type as in *N. rarinervis*, the veins only being more curved, simple, not divided or inflated on the sides. The form of the lateral leaflets much longer at the base of the pinnæ, some of them slightly cuspidate, lobed or undulate; the thick texture of the pinnules, which leave a deep impression upon the stone, authorize a specific separation. A still more fragmentary specimen represents a terminal pinnule, which, shorter and twice as broad as that of *N. rarinervis*, bears on one side, above the middle, a deeply cut, oblong, obtuse lobe. This character has not been observed in any of the numerous specimens of the former species.

Habitat—Mazon creek only. Collection of the Museum of Comp. Zool. Cambridge, N. 228, 229.

NEUROPTERIS DESORII, *Lesqx., Pl. XIV, Figs. 1–7; Pl. XV, Fig. 1.*

Boston Journ. S. N. H., vol. VI, p. 418. Geol. of Penn'a, 1858, p. 859, Pl. V, f. 11, 12. Pl. XX, f. 6–8. Geo. Rt. Ill., II, p. 430. Schp., Pal. Veg. I, p. 447.

Fronds large, pinnate or dichotomous; pinnæ either long, open, inclined upwards, linear-lanceolate; or short, in right angle to the rachis; pinnules dimorphous, according to their position on the main rachis, or on its branches. On the pinnæ they are opposite, generally lanceolate, gradually narrowed to an obtuse apex, undulate or lobed; on the rachis they are shorter, broader, deltoid, diversely cut in obtuse unequal lobes; costa distinct, either more or less enlarged at the base, effaced upwards, or thin and continuous from the base to the point; lateral veins distinct, thin, forking twice.

The subdivision of the fronds and the shape of the pinnules of this species, are more variable than in any other of the group. The fronds pinnately dichotomous, like those of *N. Clarksoni*, bear also, like this Fern, leaflets of variable shape, according to their position upon the pinnæ or the main rachis. These are broader, shorter, more deeply lobed, and far different in size, as in Atl., Pl. XIV, f. 4; the others more generally lanceolate, entire, as f. 2 and 3, are undulate, lobed at the base, even pinnately lobed, as in Pl. XV, f. 1; generally opposite, distant in the lower part of the pinnæ, close towards the top, and then gradually connate, forming a compound lanceolate, pinnately lobed and obtusely pointed terminal pinnule. The cyclopterid leaflets, Pl. XIV, f. 5 and 6, are cut, lobed or lacerated in various ways; sometimes, as in f. 6, prolonged on one side at the base into an enlarged reniform dentate lobe. The veins distinct, thin and close, are not flattened, as in *N. rarinervis*, but cylindrical or sharply cut; the substance of the leaves is about of the same thickness, its surface is polished, and this, with the distinctness of the veins, gives to the fragments of the plant a peculiar facies which enables the student to recall them easily to the type.

All the specimens described and figured in the Geol. of Penn'a, 1858, l. c., represent mere small fragments of this Fern, even mere pinnules. They were, however, all referred to the species before larger parts of the pinnæ had been found. The rachis is flat, broad, distinctly striate.

In considering the form of the pinnules, *N. coriacea* has more affinity to this species than to *N. rarinervis*. The only essential difference is in the more coriaceous texture, in the surface, which in *N. coriacea* is opaque, not shining, and in the more distant lateral nerves.

Habitat—Upper beds of the anthracite; Salem and Gate vein, near Pottsville; Blakely vein near Archbald; Wilkesbarre, not rare at these localities; found also at Cannelton, by Mr. I. F. Mansfield; not seen in Illinois.

NEUROPTERIS GERMARI, *Goepp.*—*Pl. XVIII, Figs. 3–5.*

Filicites crispus, Germ. and Kaulf., Abdr., p. 229, Pl. LXVI, f. 6.
Adiantites Germari, Goepp., Syst., p. 218. Schp., Paleont. Veget., 1, p. 426.
Cyclopteris Germari, Lesqx., Geol. of Penn'a, 1858, p. 856 Pl. V, f. 5.

Pinnately divided; pinnules thick and flat, sessile, enlarged at the point of attachment, rounded in outline, entire or variously lobed or lacinate; veins flabellate from the base, dichotomous, distant and distinct.

Schimper remarks on this species that it is unsatisfactorily known. Our specimens afford a little more light on its characters, but as they are all fragmentary, representing small parts of pinnæ, there is still a degree of uncertainty about the true relation of this peculiar Fern. Atl., F. 3 is a separate pinnule, apparently cut in the middle into two large lobes, with borders diversely lobate or lacinate, and with the nervation of this species. F. 5, copied from the Geol. of Penn'a, 1858, is part of a pinna, with broad, striate rachis and pinnules opposite, round in outline, more or less cut in irregular accuminate lobes on the upper side, entire on the lower, enlarged at the base, with veins parallel, in emerging from the rachis, or odontopterid, as in the leaflet figured by Germar and Kaulfus. F. 4 is a branch with broad flat striate rachis, like that of f. 5, bearing on one side seven pinnules, the two superior ones obtusely, irregularly lobate, the others with the upper borders lacinate, the lower merely obtusely lobed. This figure is so like that of *Odontopteris Reichiana*, as represented in Gein., Verst., Pl. XXVI, f. 4, that it seems positively referable to this species. The nervation, however, is more neuropterid, and the undivided lobes are all round or very obtuse, none of them pointed, as in the European plant. The thick substance of the leaflets also, as marked in our specimens and in *Filicites crispus*, Germ., and *Adiantites Germari*, Goep., species united by Geinitz to *Odontopteris Reichiana*, evidently separate these plants from *Fucoides Crispus*, Gutb., Abdr., pl. I, f. 11, and *F. dentatus*, Gutb., ibid., f. 1, 2, 4, which, like *Odontopteris Reichiana*, are of a thin substance, and have a different nervation. I have not seen any European specimens representing these two last species, which I consider as referable to *Rhacophyllum*, without relation to *Odontopteris Reichiana*, of the same author, as figured Pl. IX, f. 1, 2, 3, 5, 7. Schimper, Paleont. Veget., adopts the same views, and cannot see how *Filicites crispus*, Germ., and *Adiantites Germari*, Goepp., may be identified with *Odentopteris Reichiana*. Neither can I see how the two last named forms, and the one which I have figured and described as *N. Germari*, might be put with *Adiantites*, a genus which has its affinity to *Archæopteris*, or to the Spenopterids. Their place is between *Neuropteris* and *Odontopteris*, like that of *O. alpina*. Atl., f. 4 is, however, essentially neuropterid. I have seen from Mazon creek still another specimen which bears, on one side of the rachis, a leaflet divided in narrow acute laciniæ from the base, like *Rhacophyllum*, while the pinnule on the other side is merely slightly lacerate or undulate on the borders. The leaflets are thick and coriaceous. Fig. 4 shows such a degree of relation to *N. Desorii*, that I was disposed to consider it as the same, and am still uncertain if it may not be a deformation of that polymorphous species. The venation has the characters of *N. Germari*, more distant veins inflated at the base, thinning near the borders, etc.

Habitat—Salem Vein, Pottsville, specimens, f. 4. Nodules of Mazon creek, spec. f. 5 and the other mentioned above, both in the collection of the Museum of Comp. Zool. of Cambridge. Specimen f. 3 is from a sub-conglomerate shale or sandstone at the horizon of the Chester limestone, in Mercer Co., Illinois, communicated by Prof. A. H. Worthen.

NEUROPTERIS CALLOSA, *Sp. nov., Pl. XVI, Figs. 1–8.*

Bipinnate; ultimate pinnæ linear; leaflets alternate, sessile by a broad base, oblong or oval, obtuse; veins flabellate from the base, strongly marked, slightly curved; cyclopterid pinnules cordate at the point of attachment, unequilateral, polymorphous.

This species is at once recognized by its thick subcoriaceous texture and its venation. The middle nerve is only marked by a depression; the veins, somewhat thick, forking once or twice, slightly curved in ascending to the borders, come out from the enlarged base of the leaflets, which in small or top pinnæ, as in f. 1, are more or less decurrent. The cyclopterid pinnules, whose reference is clearly made by the characters of the nervation, are broadly reniform in outline, more or less equilateral at the base, with the borders entire or cut in short, obtuse or acute, irregular lobes. F. 5 shows that palmate division already remarkable in leaflets of *Neuropteris hirsuta* and *N. angustifolia*. This species differs from the former by thinner, closer veins, not or little inflated towards the base, and from the following by the entire borders of the leaflets, a close venation, etc.

Habitat—Upper Coal strata of Penna. and Ohio. New Philadelphia, between Pottsville and Tamaqua, from a vein of coal considered the equivalent of the Salem. More abundant at Pomeroy; two specimens of cyclopterid pinnules are from Wilkesbarre. All belong to the Museum of Comp. Zool. of Cambridge.

NEUROPTERIS CRENULATA? *Brgt., Pl. XVI, Figs. 9–11.*

Brgt., Hist. d. Veg. foss., p. 234, Pl. LXIV, f. 2, 2a. Lesqx., Geol. of Penn'a, 1858, p. 859, Pl. V, f. 6. Schp., Paleont. Veget., I, p. 442.

Frond bipinnate; pinnæ long, linear; pinnules open, sessile, distant, alternate or opposite, ovate, deeply cordate; borders more or less distinctly crenulate; veins dichotomous, distant, slightly curved towards the borders.

If the plant figured and described here agrees in some of its characters with Brongniart's species, it is so different in others, that identity cannot be positively asserted. According to the author, the pinnules are contracted at the base, not cordate, and his figures show them pedicellate, not sessile. The venation seems to agree; for if the veins are described as thin and distant, they are figured thick, both characters apparently contradictory, but agreeing with what is seen upon the American specimens. As far as it is known, the pinnules vary little in shape and size; they average three centimeters in length and nearly two in width measured towards the enlarged base, ovate, obtuse, generally slightly contracted in the middle; and evidently sessile. The midrib is formed by confluence of the base of the veins, which fork twice and pass up with a slight curve to the crenulate borders. The veins generally thin, often appear thick by immersion into the epidermis which they cut into deep narrow furrows. Brongniart says of his enlarged f. 2*a*, that it represents the veins too thick. It is the same with f. 10*a* of our plate, the veins are more exactly represented upon the pinnules of natural size. The crenulations of the borders are caused by immersion of the veins into the parenchyma, forcing it out and protruding between them; some of the leaflets where the epidermis is erased are entire, as seen in the upper fragment of f. 9. This is also different from what is marked upon the enlarged f. 2, of Brongniart, where the veins are all ending into the teeth. I am not perfectly satisfied that the specimen f. 11, represents the same species. It has the same characters of nervation; but the leaflets are longer, narrower, and the borders more irregularly crenate. It evidently shows two segments of upper pinnæ bearing the terminal pinnules and a few of those underneath, none of them having the basilar part preserved.

Habitat—Wilkesbarre. The leaflet figured in Geol. of Penn'a, l. c., is from Salem vein. It is narrowed to the point of attachment and more irregularly crenulate, having its affinity with f. 11, made from a specimen from the Tunnel vein, near Tremont, same horizon as the Salem vein; where spec. of f. 9 and 10 have been obtained. I have seen, also, a few specimens from Cannelton.

NEUROPTERIS EVENII, *Lesqx., Pl. XVIII, Fig. 7.*

Geol. Rep. of Ill., II, p. 430, Pl. 36, f. 4. Schp., Paleont. Veget., III, p. 475.

Pinnately divided; pinnules alternate, distant, ovate, cordate at base, short pedicelled; veins distant, flabellate from the base, or derived from a thin midrib; curved.

This form is a remarkable one. By the shape of the leaflets, their thick substance and the venation, it is similar to the former species, and though the borders are evidently entire, it would be impossible to separate it, but for the short, curved, distinct pedicel, by which they are attached to the rachis, The veins also, clearly marked, though thin, are not immersed into the parenchyma. As no other specimen similar to this has ever been seen, I am unable to ascertain if the differences are constant, or if it represents a mere variety. Specimens from Cannelton referable to the former species have the borders of the pinnules entire, but the leaflets are sessile.

Habitat—Mazon creek. The specimen was formerly preserved in the cabinet of Mr. Jos. Even, of Morris.

NEUROPTERIS AGASSIZI, *Sp. nov., Pl. XVII, Figs. 1–4.*

Frond large; pinnæ simple, linear; pinnules sessile, or short-pedicellate, reniform, semi-circular, or oblong-lanceolate, obtuse, either smaller and undivided, or larger and lobed; borders entire or crenulate; veins flabellate and dichotomous from the base, curved backwards, thick, and distant.

This Fern, the most beautiful of all those of this genus, is remarkable, especially by the peculiar divisions of its large pinnules, attached to a narrow cylindrical rachis. The pinnules are either simple, (not lobed,) round or reniform, truncate, sessile or pedicelled at the base, two centimeters long, and two and a half centimeters broad, at least; or much larger, three to six centimeters long, two to five centimeters broad at the base, truncate and sessile, pinnately cut on the borders, in the direction of the veins, into two to four obtuse lobes, and half round at the top. The borders in the small leaflets are crenulate or nearly entire; in the larger pinnules the teeth are more distinct and generally tipped with a short point; the venation is cyclopterid in the small leaflets; the large ones have, like *N. crenulata*, a medial nerve formed by continuity of the base of the veins, inflated downwards. The veins are thick, immersed into the parenchyma, or exposed at the surface; much curved backwards, forking twice, and distant.

Prof. J. E. Teschemacher has figured a small fragment of this species in Boston Journ. S. N. H., vol. V, Pl. XXXIV, merely mentioning it, p. 383, as referable to *Neuropteris* or *Odontopteris*. This figure is copied, f. 4. The same specimen bears some lanceolate leaflets, comparable by form and size to those of *Odontopteris Alpina*, with a cyclopterid nervation and entire borders.

This species is not a true *Neuropteris*. With the two former ones and *Odontopteris Alpina* it constitutes a peculiar group, which need to be separated under a new generic name.

Habitat — Mount Hope coal mines, near Portsmouth, Rhode Island, communicated by Mr. J. H. Clark, of Newport in numerous specimens, now in the museum of Comp. Zool. of Cambridge. Prof. Teschmacher had his specimen from the same locality. I have never seen any from another.

§ . ANOMALOUS.

NEUROPTERIS ANOMALA, *Sp. nov., Pl. VII, Fig. 1.*

Pinnately divided. Pinnæ large, lanceolate; rachis broad, flat, striate; pinnules opposite, open, truncate to a *very short pedicel, ovate-lanceolate, acuminate; veins distant, curved, dichotomous, forked two or three times, irregularly sub-dividing into thin, sparse filaments; midrib thick at the base, distinct to the middle of the laminæ.*

The fronds of this pecular species seem to have been very large. The specimen figured represents a simple pinna, twenty-five centimeters long, with seven pairs of opposite, distant pinnules, five to seven centimeters long and two to two and one half centimeters broad, in the middle. The terminal pinnule is free, short pedicellate, of the same form, only slightly smaller. The lateral pinnules abruptly rounded to the nearly equilateral base, are subtruncate, attached to the rachis by a short pedicel formed by the enlarged costa; the lower are generally ovate, more or less rapidly acuminate, the upper ones oblong and sometimes, as seen on a specimen not figured, linear from the base to above the middle. In this last specimen none of the leaflets are preserved entire, the longer fragment is six centimeters and its borders are parallel for the whole length. The venation is of a peculiar type. The middle nerve is a prolongation of fasciles of vessels which, parallel in the flat rachis, diverge into each pinnule, and from the midrib, by the same kind of sub-division, curve towards the borders. They generally fork twice and besides, are sub-divided in thread-like, thin filaments, which diverge obliquely across the laminæ without uniting with other veins, though often crossing them before they become effaced. The epidermis is thin and pellucid when humected, and thus, the distribution of the veins is discernable in all its details as seen in the enlarged f. 1*a*. The other specimen has the lateral veins more compact but also flattened and subdivided, the thread-like vessels being closer and more generally parallel. The flat rachis is regularly striate by the parallel juxtaposition of the vascular bundles.

Though, by the shape of the leaflets, this species is comparable to *Neuropteris acuminata*, Brgt., it is quite distinct from it by all the other characters. I have observed sometimes a like abnormal subdivision of the veins in thin threads, in specimens of *Odontopteris Schlotheimii*, when found in an advanced state of maceration.

Habitat—The specimen figured, No. 430 of the collection of the Museum of Comp. Zool. of Cambridge, is from the gray roof shale of the coal of Morris, Ill., obtained by Mr. Jos. Even. Prof. Thos. C. Porter found the second specimen at the Tunnel Vein of Sharp Mt. below Tremont and kindly presented it to the Survey.

NEUROPTERIS VERBENÆFOLIA, *Lesqx.*, *Pl. XVIII, Figs. 1, 2.*

Geol. Rept. of Ill., II, p. 431, Pl. XXXVII, f. 1; IV, p. 385, Pl. VI, f. 5, 6. Schp., Paleont. Veget., III, p. 476.

Frond pinnate; rachis cylindrical, thinly striate; pinnæ simple, apparently long; pinnules large, oblong, or ovate, rounded at the base to a short, flat pedicel, serrate on the borders; midrib thin, effaced above the middle; veins thin, dichotomous, moderately curved in passing to the borders.

The first leaflet found of this fine and remarkable species is larger than those figured here and split in the middle; its base is partly destroyed. Two others, found after at the same locality, represent exactly the characters observed on the first leaflet, and besides show the mode of attachment of the pinnules. They vary from ten to eleven centimeters long, and proportionally broad. The veins are thin, partly derived from the enlarged base, partly from the narrow midrib, generally divided three or four times. In the specimen f. 1, the pinnules by their form and the short teeth of the borders, somewhat resemble those of *N. crenulata;* but the enlarged base, the venation, as also the teeth, sharp though short, and entered by the veins, distinctly refer it to this species. The leaflets appear to have been of a delicate texture. The upper ones, in f. 2, are somewhat erased and punctulate, or spotted by maceration.

Prof. Schimper, l. c., remarks that this splendid fern, easily recognizable by its leaflets, regularly dentate, and of a size unknown in the Genus *Neuropteris*, has no analogy to any species either of living or of fossil Ferns, except, perhaps, of some *Marattiæ.* The form and nervation of the pinnules recall those of the genus *Phyllopteris*, Brgt.

Habitat—Nodules of Mazon creek, Ill.—all the specimens.

NEUROPTERIS BIFORMIS, *Sp. nov., Pl. XIII, Fig. 7.*

Bipinnate; pinnæ lanceolate; pinnules coriaceous, close and very oblique in the lower part, distant and in right angle, towards the top, lanceolate, obtuse, rounded on both sides to the midrib, and equilateral at the base; border undulate; middle nerve thick and persistent to the point; lateral veins curved backwards, close, and inflated, distinct, simple or forking once or twice.

This fragment of a pinna is the only representive of the species. The substance of the leaflets is thick, coriaceous, with the surface shining; the pinnules close near the base and more distant in the upper part, give to the plant the appearance of being composed of two different species. The veins are curved backward, like those of an *Alethopteris* or *Callipteridium*, and but for the mode of attachment of the leaflets, the species would be referable to this last genus. The terminal pinnule, of which the base only is preserved, has the mode of attachment of an *Alethopteris.*

Habitat—The specimen figured, No. 34 of the collection of Prof. Eug. A. Smith, of Tuscaloosa, is derived from the Alabama coal measures, but the locality is not marked.

SPECIES INSUFFICIENTLY KNOWN.

NEUROPTERIS ASPERA, *Sp. nov., Pl. XIII, Figs. 10–12.*

Pinnate; pinnules very oblique, narrowly lanceolate, accuminate; midrib thin, dividing near the top; lateral veins dichotomous, curved, close, salient.

As positively answering to this description, I have seen of this Fern only the three small specimens figured. The facies of the leaflets is remarkable, on account of the very deeply marked, close, cylindrical, rough veins, which fork three to five times, and though very thin, are easily counted along the borders, numbering eight per millimeter. They come out of the midrib in an acute angle, and distinctly curve to the borders from the middle of the areas. The fragments may represent pinnules not yet fully developed at the top of opening pinnæ.

This supposition seems confirmed by the characters of another fragment of a pinna representing five linear-lanceolate pinnules, curved upwards, like those of f. 11, about of the same form, bearing each two round leaflets at the base. The veins very distinct, sharp, but not as close as in the specimen described, number four per millimeter; the surface is hairy. This specimen apparently represents the top of a young pinna of *Odontopteris Worthenii.*

Quite recently I have found in the Cabinet of Princeton College another specimen (M. 764) which affords some more evidence on these plants. It is a pinna nine and a half centimeters long, with the lower pinnules alternate, the four terminal ones fasciculate, all of them very oblique, curved upwards or falcate from the point of attachment, linear-lanceolate, obtusely accuminate, five and a half centimeters long, eleven millimeters broad at the base, with borders entire or slightly undulate. The medial nerve is broad, flat, very distinct; the lateral veins are also sharply cut, slightly curved, forking three to four times, distant on the borders; the surface is covered by a coating of rigid polished long hairs, generally disposed in the direction of the veins, longer than those of *N. hirsuta*, all characters indicating a close relation to *Odontopteris Worthenii.*

Habitat—Murphysborough, Ill., low coal, in the same bed of shale with *Odontopteris Worthenii*. The last specimen is from Cannelton, Pa.—Mr. I. F. Mansfield.

NEUROPTERIS FISSA, *Lesqx.*

Geol. of Penn'a, 1858, p. 857, Pl. III, f. 2.

Pinnule oval, obtuse, truncate or cordate at the base; borders undulate; veins dichotomous from a thin middle nerve, thin, distant, undulate, and slightly curving in passing to the borders, where they become effaced.

The leaflet is split in the middle, by compression it seems.

It cannot be compared, on account of its venation, to the cyclopterid pinnules of *N. rarinervis*, but may be related to *N. dilatata*, Ll. & Hutt. The pinnule has a distinct costa, and therefore represents a true *Neuropteris*.

Habitat—Gate vein, near Pottsville, Pa.

NEUROPTERIS MINOR, *Lesqx.*

Geol. of Penn'a, 1858, p. 859, Pl. III, Fig. 4.

Frond bipinnate; pinnæ short, linear, sessile upon a thick round striate rachis, pinnules oval, sessile, separated, or united in the upper part of the pinnæ; terminal leaflets very small oval; veins thick, twice forked, obsolete.

This species is apparently made from an erased specimen of *N. Desorii.*

Habitat—Tamaqua, found by Prof. E. Desor.

NEUROPTERIS ACUMINATA, *Brgt.*

Hist. d. Veg. foss., p. 229, Pl. LXIII, f. 4. Ll. and Hutt., foss. fl., I, Pl. LI.

Filicites acuminatus, Schloth., Petref., p. 412.

Neuropteris smilacifolia, Sternb., Fl. d. Vorv., II, p. 29–33.

Frond pinnate or bipinnate; pinnules alternate, short pedicelled, auriculate-cordate, symmetrical, acuminate, entire.

I have seen only one specimen with three detached leaflets which might be referred to this species. They are enlarged at the cordate base one of them with a short pedicel and acuminate. They have exactly the shape of those figured by Brongniart, still more resembling those figured by Ll. and Hutt. The veins are thin but distinct, many times forking from a narrow costa effaced above the middle. The nervation is not described by the author. As these leaflets are detached and as I have never seen any other specimen in the coal measures, I am not certain about their reference.

Habitat—Black vein of W. W. Wood, near Pottsville, specimen No. 276, of the Collection of the Museum Comp. Zool., Cambridge.

ODONTOPTERIS, *Brgt.*

Fronds large, bipinnate; pinnæ opposite or sub-alternate; pinnules of various forms, generally oblong, obtuse, joined to the rachis by their whole base sometimes decurrent, either disjointed and separate to the base, or connate to the middle, generally becoming confluent towards the top of the pinnæ and gradually effaced in passing to a terminal leaflet; lower pinnules sometimes attached to the main rachis and difform; veins emerging from the rachis, more rarely from a midrib; veinlets thin, dichotomous, diverging straight or in curve, in passing to the borders.

This genus is so intimately allied to *Neuropteris*, that some of its species have been considered as indifferently referable to one or to the other of the genera. As far as I knew these plants, from American specimens, they differ especially by the absence of the large round cyclopterid leaflets, generally observed with species of *Neuropteris* and which I have not as yet remarked with *Odontopteris*. Grand' Eury however refers to this genus a number of those cyclopterid leaves, (among others *C. trichomanoides*, Brgt.) which I have considered and described as *Neuropteris* from identity of some peculiar characters.

The species of *Odontopteris*, like those of *Neuropteris*, were bushy ferns with immense fronds. The celebrated French author, quoted above, has seen them fifteen to twenty feet long, with petioles thirty to forty centimeters broad. To him also we owe, it seems, the discovery of the fructification of this kind of Ferns. He has represented in his Fl. carb., Pl. XIII, f. 4, leaflets of a species which he names *Odontopteris sorifera*, bearing upon the end of each division of the veins, at the point of contact to the borders, oval inflated corpuscles, apparently sporanges, slightly emarginate at the outside, passing a little out of the borders, and split in the length. They are remarkably similar to the fructifications of some living *Angiopteris* or *Marattia* like *M. purpurascens* or *M. fraxinea*, Sm., and for that reason as also on account of the analogy of structure of the petiole, both this author and Brongniart relate *Odontopteris* and *Neuropteris* to the tribe of the *Marattiæ*.

Fragments of pinnæ of *Odontopteris Schlotheimii* and *O. britannica*, bearing inflated pinnules, were formerly considered by Goeppert and Geinitz as representing the fruiting organs of these species. They have been later recognized by the authors themselves as a peculiar kind of deformation without relation to fructifications. A leaflet of this kind is figured Atl., Pl. XX, f. 2.

In order to facilitate the classification, some authors have separated the species of *Odontopteris* into peculiar groups, according to the characters of the venation. Weiss, especially, Foss. fl., p. 31, admits three subgenera as follows:

1st. *Odontopterids proper* (*Xenopteris*), for species with pinnules marked by numerous, equal, parallel veins, coming out of the rachis without any midrib.

2d. *Mixoneura* for those with leaflets of a mixed venation, or with pinnules xenopterid-neuropterid and even cyclopterid in one and the same species. *Odontopteris Alpina*, Atl., Pl. XIX, is a fine exemplification of the characters of this group.

3d. For the species whose leaflets have a midrib more or less distinct, oblique, vanishing upwards, and besides, numerous secondary veins, equal and parallel, emerging from the rachis.

As far as evidenced by American species, the two first divisions might be admitted for a classification; but this could be of little advantage for the student, as it is often very difficult to decide, from imperfect fragments, to which of these groups the specimens may be referable. It is the case for separate pinnules of *O. Alpina*.

ODONTOPTERIS TENUINERVIS, *Lesqx.*, *Pl. XXII, Figs. 2, 3.*

Neuropteris tenuinervis, Lesqx., Geol. of Penn'a, p. 859, Pl. V, f. 7, 8.

Pinnæ apparently linear; pinnules oblong, enlarged upwards, obtuse, entire or irregularly denticulate at the apex; borders undulate; middle nerve very thin, effaced at the middle by subdivision; veins from the rachis or *from the midrib, slightly arched, dichotomous, thin and close.*

I have not seen any other specimens than the two figured. By their mixed nervation, they are referable to *Neuropteris*, as evidently as to *Odontopteris*. Their relation to *O. subcuneata*, is indicated by the form of the pinnules and for this reason they have their place in this genus. The two leaflets f. 3, irregularly toothed or lacerated in the upper part, are comparable by this character to *Neuropteris dentata*, Pl. V, f. 7, 8 a species which, by the form of the pinnules and the nervation is, however, a *Neuropteris*.

The rachis of this fern is comparatively large, striate.

Habitat—Gate vein, near Pottsville; very rare.

ODONTOPTERIS ALPINA, *Gein., Pl. XIX, Figs. 1–5.*

Neuropteris alpina, St., Fl. d. Vorw., II, p. 76, Pl. XXII, f. 2. Heer, Fl. foss., Helv., IV, p. 26, Pl. VI, f. 14, 15.

Odontopteris alpina, Gein., Verst., p. 20, Pl. XXVI, f. 12; XXVII, f. 1

O. obtusa, Brgt., Hist. d. veg. foss., p. 255, Pl. LXXVIII, (fide Schimper) Ll. and Hutt., Foss. fl., 1, Pl. XL.

O. Lescurii? H. C. Wood, Trans. Am. Phil. Soc., v. XIII, p. 348, Pl. VIII f. 8, 8c.

Frond large, with a broad flattened striate rachis; pinnæ irregularly divided; pinnules either large, oblong-obtuse, or smaller, round or reniform, sessile by their whole base, or rounded to a broad point of attachment; veins dichotomous, curved, emerging from the rachis and parallel, or from the narrowed base and flabellate.

The beautiful specimens figured here expose the variety of characters of this remarkable Fern. F. 1 has two kinds of divisions of the main rachis; one by forking in an acute angle of divergence, like the dichotomy of a large branch, while on the other side, the pinnæ with a narrow rachis, are short, in right angle or even turned back. The pinnules have also two marked characters of shape and venation; the large ones, oblong-obtuse, two to four centimeters long, one centimeter broad, oblique or in right angle, f. 1, are with few exceptions neuropterid; while those of f. 2, close or distant, and much smaller, vary in size and shape, and have on a same pinna the venation of both *Neuropteris* and

Odontopteris. The veins are distant and distinct, forking generally twice; the ultimate pinnules are long, lanceolate, obtuse, the upper lateral leaflets becoming confluent at their base.

The species is not satisfactorily represented by European authors. Sternberg and Heer merely figure an ultimate pinna, with some of the leaflets obtusely pointed. Geinitz has two fragments, one with pinnules oblong-obtuse, like those of Atl., f. 1, the other with small, short divisions, connate to near the top, both with veins undulate, a character which I have not remarked in any American specimen. Of *O. obtusa*, Ll. and Hutt., Goeppert makes *O. Lindleyana*, which Schimper refers to this species. The figure given by the English author represents a mere fragment of a pinna, with small oval pinnules apparently of a different type.

The fragment described as *O. Lescurii*, by Dr. H. C. Wood, l. c., apparently represents a variety of this species with leaflets broader at the base, even enlarged into half round lobes, and intermediate between *O. Alpina* and *Neuropteris Agassizi.* It may be a good species.

Habitat—Mount Hope coal mines, near Newport, Rhode Island. Jas. H. Clark. The museum of Comp. Zool. of Cambridge has numerous specimens of the species. It is also in the cabinet of Mr. R. D. Lacoe, of Pittston, from Olyphant, Pa., No. 1 Vein.

ODONTOPTERIS NEWBERRYI, *Lesqx.*

Odontopteris neuropteroides, Newb'y, Geol. Rept. of Ohio, Paleont., I, p. 381, Pl. XLVII, f. 1–3.*

Frond bipinnate; pinnæ of lower part of frond linear in outline, composed of twenty or more pinnules, of which the terminal one is large and irregular, as in Neuropteris. the upper pinnæ shorter and broader, with the terminal pinnule relatively smaller; pinnules of various form, those near the base of lower pinnæ ovoid and cordate, precisely like those of Neuropteris; upper ones more or less cuneate, strongly decurrent, the upper side of base free, as

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* Name pre-occupied by Rœmer, Pflanzen des productiven Kohleng. am Hartz, 1860, Paleont. Vol. IV, p. 187, Pl. XXX, f. 2.

in Otopteris; pinnules of the upper pinnæ linear, often acute, connate and decurrent at base.

This species has, by the diversity of some of its characters, a relation to the former; the venation, however, is much closer. By the shape of the pinnules it may be compared to *Odontopteris obtusa*, as figured by Brgt., Hist. d. Veg. foss., Pl. 78, f. 4. It is related to *O. neuropteroides*, Rœm., l. c., by the terminal pinnules of the same form; but the lateral ones are larger and comparatively broader. It is a distinct and fine species.

Habitat—Coal No. 1, of Mahoning and Summit counties, Ohio. Also on Mill creek, near Youngstown, Ohio. I owe to Prof. Wm. M. Fontaine the communication of specimens from the conglomerate series of West Virginia, Quinnimont coal seam, which are most probably referable to the species. They have been described by the discoverer in Amer. Journ. Sci., 3d series, vol. XI, p. 378, as representing, perhaps, a *Neuropteris*. Prof. Newberry rightly remarks that separate leaflets of this fern look precisely like those of *Neuropteris*.

ODONTOPTERIS CORNUTA, *Sp. nov., Pl. XXII, Figs. 7–9.*

Frond pinnate; rachis thick, obtusely striate; pinnules long, lanceolate in outline, entire in the lower part, divided from the middle upwards into lateral, linear-lanceolate, obtusely acuminate lobes, gradually shorter and more obtuse towards the base of a long lanceolate terminal pinnule; veins dichotomous, more or less curved, emerging from a distinct primary nerve, or from thin lateral ones.

We have of this remarkable species only four specimens, three of which, the best preserved, have been figured. The best, f. 8, an ultimate pinna, is apparently attached to a main thick rachis, of which a fragment only is preserved. The pinna is ten centimeters long, two centimeters broad in the middle, rounded at the upper basilar side to the point of attachment, more enlarged, and slightly auricled on the other, entire and gradually enlarging up from the base to the middle. The upper part is irregularly or pinnately divided into linear, obtusely acuminate, lateral segments, obliquely diverging, about two centimeters long, passing up to shorter, three to five millimeters half round lobes, at the base of a long terminal linear-lanceolate pinnule, gradually narrowed to an obtuse apex. The characters of f. 7 are about the same; it shows only the upper part of a much larger pinna, which, if entire, would be about twenty centimeters long. F. 9 represents another of those polymorphous divisions, attached to the rachis, whose analogy of shape is remarked in *Neuropteris Clarksoni*, *O. Alpina*, etc. It is sessile, truncate, or slightly cordate at the base, only four and one half centimeters long, and palmately irregularly divided from below the middle into five lobes, of about the same shape as in f. 8. The midrib in this specimen is indistinctly marked upon all the lobes. The lateral veins are somewhat thick, not very close, forking three or four times, much curved backwards, near the base, nearly straight, in the lobes; numbering fifteen to twenty per centimeter along the borders. The substance is subcoriaceous. When the somewhat thick epidermis is erased, the veins appear under it, and in some places, as split in filaments, irregularly passing from one to another, as in pinnules of *Dictyopteris*.

This species has some distant likeness to the following, and I supposed at first that it might be referable to the same. By comparison of specimens the veins are seen to be of a different character, especially thicker and closer.

Habitat — Cannelton. Discovered by Mr. I. F. Mansfield; not seen elsewhere.

ODONTOPTERIS HETEROPHYLLA, *Lesqx.*, *Pl. XXI, Fig. 6.*

Geol. Rept. of Ill., II, p. 433, Pl. XXXVIII, f. 2–5. Schp., Paleont. Veget., I, p. 464.

Frond bipinnately, irregularly divided; pinnæ lanceolate in outline; pinnules alternate, entire, obovate, decurring and distinct, the lowest reniform or half round, becoming smaller, lanceolate, pointed and recurved in the secondary divisions; terminal pinnules linear-obtuse or obovate, sometimes reniform; veins mostly derived from *the rachis, thin, parallel, except in the basilar round pinnules, distant, generally forking once.*

This species is extremely polymorphous. Of the specimens obtained at the same locality, numerous enough, but all fragmentary, I have figured four, in the Geol. Rept. of Ill., l. c.—F. 1 is represented upon our plate; f. 2 and 3 are fragments of pinnæ with broad, distinctly and distantly striate rachis, alternately divided in pinnules of conform shape, obovate or cuneate-obtuse, decurring but not connate, rather distant, five to twenty millimeters long, three to seven millimeters broad, near the top, where they are the widest. The terminal pinnule is two and a half centimeters long, one centimeter broad in the middle, where it is enlarged, sub-lobate and free, the upper lateral pinnules not being confluent with it. F. 4, of the same report, represents two other lateral pinnules, similar to the lower branches of Atl., f. 6, with the lower leaflets half round or reniform, the veins flabellate or curved, dichotomous, and the upper divisions oblong or obovate, like the upper leaflet of the middle branch of the same figure.

The fragment f. 6 seems to represent a rachioid pinnule, like f. 9, of the former species.

No other *Odontopteris* known until now from European authors has any relation to this. Two small branches, figured by Dr. H. C. Wood, Jr., Trans. Am. Phil. Soc., Vol. XIII, Pl. VIII, f. 8*d* and 9, and described p. 348, as *O. Lescurii*, (omitting f. 8, 8*a*, 8*b*) may represent this species. The pinnules have the same form as the upper ones of f. 2, of the Ill. Rept., l. c. But the specimens are too small for positive determination, and the venation is not indicated.

Habitat—Murphysborough. It is not rare in the roof shale of the coal, there, but until now it has been found only in small fragments. A specimen has been sent by Mr. Wm. Gibson from Spring Creek, Indiana.

ODONTOPTERIS WORTHENII, *Lesqx. Pl. XXII, Fig. 1.*

Geol. Rept. of Ill., II, p. 432, Pl. XXXVI, f. 1. Schp., Paleont. Veget., I, p. 463.

Frond pinnate; rachis thick, irregularly striate; upper *pinnæ longer, linear-lanceolate, pinnately divided into obovate or oblong-obtuse lobes, connate at the base and subdecurrent, confluent towards the top, passing into a lanceolate obtuse terminal pinnule; lower divisions pinnatifid at the top and the base only, with the middle part entire; lower lobes half attached to the rachis, enlarged upwards, reniform; veins thin and close, dichotomous, curved; surface hairy.*

We have many specimens of this fine species, but none better than the one figured. The others mostly represent merely simple pinnæ, pinnately lobed on one side, entire on the other, like the lower one of f. 1. Some pinnules are entire and similar in shape to those of *Neuropteris decipiens*—smaller, however. The veins are all from a thick middle nerve, which represents the rachis of a secondary pinna; they appear extremely thin in the middle of the lamina, on account of the hairy surface which render them confused; at the borders and joining it, they are inflated, distinct, numbering only thirty to thirty-five per centimeter. The species is, like the former, remarkable by the variable and abnormal divisions of its pinnæ.

Habitat—Mazon creek, in nodules; received from Mr. S. S. Strong. I have seen also one specimen in the collection of Mr. R. D. Lacoe, of Pittston.

ODONTOPTERIS ALATA, *Lesqx. Pl. XXI, Fig. 1.*

Cat. Carb. foss. pl., p. 6, Pl. I, f. 1. Schp., Paleont. Veget., I, p. 456.

Frond bipinnate; pinnæ oblique, linear, sub-opposite; pinnules ovate, subrhomboidal, obtuse, confluent to the middle and decurrent; terminal pinnule lanceolate, obtusely acuminate, lobate at the base by the confluent upper lateral lobes; basilar leaflets attached to the rachis by a broad base, quadrangular or broadly cuneate, truncate or slightly emarginate at top; veins parallel in joining the rachis, thin but distinct, forking once at or above the middle.

This species is closely related to the following, and according to Schimper's remark, the fragment figured may represent the upper part of a small pinna of the same plant. It differs by the pinnules comparatively smaller, the largest one centimeter long, none broader than five millimeters, oblong, obtuse, very oblique to the rachis (never pointed and falcate at the upper part, as in *O. Brardii*); by the basilar pinnules attached to the rachis, and by the terminal leaflet larger, much longer, lanceolate, and obtusely pointed. Schimper remarks that in *O. Brardii*, the basilar pinnules, in the upper part of the pinnæ, are also attached to the rachis. This is seen, indeed, Pl. 75, of Brgt., l. c., where a pair of these pinnules is joined to the rachis as decurring to it at the base of one of the upper pinnæ, and as a prolongation of them. Such a partial displacement of the lower pinnules is seen also upon some species of *Neuropteris*; but it seems then casual, while, on our specimen, the lower pair of leaflets appear normally attached to the main rachis, the one below the terminal pinnule being in the middle of the space separating the two upper branches. The terminal leaflet of *O. Brardii*, also, is always very small, oval, and in no way similar to that of this species. The venation, however, is positively of the same character, and notwithstanding the differences mentioned above, the relation appears so close, that I might have admitted Schimper's opinion and considered this plant as a mere variety of *O. Brardii*, if the specimens representing both forms had been found at the same locality, and did not have altogether a different facies.

Habitat—Tremont; probably from the Tunnel vein. The specimen was found by Mr. P. W. Sheafer, of Pottsville, and presented to the Cabinet of the Scientific Society of that locality.

ODONTOPTERIS BRARDII, *Brgt.—Pl. XXI, Fig. 2.*

Brgt., Hist. d. Veg. foss., p. 252, Pl. LXXV and LXXVI. Schp., Paleont. Veget., I, p. 454. Heer, Fl. foss. Helv., IV, p. 25, Pl. VII, f. 1–7.

O. intermedia, Lesqx., Geol. Rept. of Arks., II, p. 313, Pl. V, f. 7.

Fronds very large, bipinnate; pinnæ alternate, from a thick sub-striate rachis, open, linear-lanceolate toward the apex; pinnules rhomboidal-ovate, scythe-shaped and acu-

minate, confluent to the middle, gradually smaller towards the top of the pinnæ, with a small ovate or ovate-lanceolate terminal leaflet; basilar pinnules attached to the base of the pinnæ, cuneate, emarginate or lobate; venation of the same character as the former, more obscurely or coarsely marked.

The Museum of Comparative Zoology of Cambridge has large specimens of this species, agreeing in their characters with those of the European form, the veins generally indistinct, or obscured by a thick epidermis. The fragment f. 2, of our plate, described as *O. intermedia*, l. c., differs from *O. Brardii*, by the more obtuse leaflets and the irregular thickness of the veins, some of them more inflated towards the base and also near the slightly crenulate borders.

Prof. I. E. Teschemacher, Boston Journ. S. N. H., v. V, p. 382, Pl. XXX, has described and finely represented the normal form of this fern, a large fragment of a pinna, from the coal mines of Rhode Island. As it is generally the case on specimens of the anthracite of that State, the leaflets expanded on one side of the pinnæ are longer and sharply acuminate, while on the other they are contracted, much shorter and nearly truncate. The same configuration is remarked in the description of *O. deformata*.

Habitat—Subconglomerate Coal, Jenny Lynd prairie, Arks. Specimens of the normal form, with very large pinnæ, are not rare in the coal of Rhode Island.

ODONTOPTERIS SQUAMOSA, *Lesqx.*

Boston Jour. S. N. H., v. VI, p. 419. Geol. of Penn'a, 1858, p. 860, Pl. XIX, f. 2.

Frond pinnate; pinnæ long, lanceolate; pinnules oblong, obtuse or truncate at the top, disconnected at the base; terminal pinnules small, oblong, obtusely lobed on the sides by connection of the upper lateral pinnules; veins very thin, close, dichotomous.

Schimper considers this form, like *O. intermedia*, as referable to *O. Brardii*. The difference is however marked.

The veins are thin, twice as close; the leaflets not connate at the base, but rather distant. It seems more closely related to *O. obtusa*, Brgt., (*O. lingulata*, Goepp.) as figured Hist. d. veg. foss., Pl. LXXVIII, f. 4, and I should have united it to this species but for the great difference in the size and shape of the terminal leaflets. In this fragment as in that figured by Brongniart, the veins are obscured by a coating of coal which covers the surface as a scaly epidermis, which is easily detached, however. The last character recognized also upon the leaflet described as *Cyclopteris laciniata*, led me to suppose that it might represent the same species, a supposition supported by identity of venation and by the discovery of these two specimens at the same locality.

Habitat—Muddy Creek, a coal vein formerly opened and now abandoned, near the road between Tremont and Pottsville, Pa.

ODONTOPTERIS SUBCUNEATA, *Bunb'y, Pl. XXII, Figs. 4 and 5.*

Bunb'y, Quat. Geol. Journ., III, p. 427, Pl. XXIII, f. 1. Lesqx., Geol. Rept. of Ill., II, p. 433, Pl. XXXVI, f. 3. Schp., Paleont. Veget., I, p. 461.

Pinnately divided; pinnæ long, linear; pinnules distant, alternate or opposite, oblique, either ovate or cuneate, obtusely acuminate, auricled and narrowed to a broad point of attachment; or obovate, broadly obtuse, drawn out at the lower base into a short half round auricle gradually effaced in the upper part of the pinnæ; terminal pinnules large, lanceolate, obtuse; veins all from the rachis, parallel at the base, dichotomous, diverging and more or less curved towards the borders.

The species is distinct and its characters recognized in all the specimens. The rachis is sometimes finely striate as by the decurring of the veins into it, a character observed by Bunbury and which is marked only upon few specimens. The pinnæ seem to have been long and linear. The leaflets, either opposite or alternate, generally distant, even near the top of pinnæ, vary in length from one and a half to three centimeters long and from one to one and a half centimeters broad, a little above the point of insertion, where they are unsymmetrical, or inflated to a short obtuse auricle. They are oblong or obovate, very obtuse, sometimes, however, obtusely acuminate, as on the left side of f. 5. The point of attachment, generally broad, is narrowed, however, in some of the large inferior pinnules into a short pedicel. The terminal pinnule is free, comparatively large, as seen f. 4. Another specimen, with upper leaflets alternate, one and a half centimeters long, has the terminal pinnule nearly linear, obtusely acuminate, six and a half centimeters long and only one centimeter broad. The venation is always odontopterid, all the veins being derived from the rachis, without any trace of a midrib, a character which evidently separates the species from *O. tenuinervis.* They are more or less curved, dichotomous, clearly marked, not very close, numbering thirty per centimeter on the borders. The substance of the leaflets is somewhat thick, not coriaceous, however. I have seen a specimen bearing a pinna with close nearly imbricate leaflets, without basilar auricles, except on the lower pair of pinnules.

Habitat—Rare in our coal measures; most of the specimens seen until now are from the nodules of Mazon Creek.

ODONTOPTERIS ÆQUALIS, *Lesqx., Pl. XXI, Fig. 8.*

Geol. Rept. of Ill., II, p. 434, Pl. 36, f. 2.

Pinnæ lanceolate; pinnules coriaceous, convex, oval or oblong, obtuse, distant, attached to the rachis by the whole base and nearly in right angle to it, oblique and connate only in the upper part of the pinnæ; terminal pinnules small, lanceolate, obtuse; veins parallel at the base, distinct, very thin, slightly diverging upwards, generally forking once above the middle; rachis smooth.

The species was described in the Rept. of Ill., l. c., from a too fragmentary specimen. Atl., F. 8, representing the largest part of a whole pinna, gives some more light upon the general characters of this Fern. It is rigid, pinnately divided into sessile pinnules, the lower ones seventeen millimeters long and one centimeter broad, nearly exactly oval, truncate at the point of attachment, all of the same form, gradually smaller towards the upper part, where they become confluent, passing to a lanceolate obtuse terminal leaflet. In the specimen of the Rept. of Ill., the leaflets are all connate at their base, but the lower ones are more deeply disjointed, and in right angle to the rachis. The substance of the pinnules is coriaceous; the surface distinctly convex; the veins immersed into the epidermis are very thin, scarcely distinguishable, one millimeter apart, diverging upwards towards the borders, but parallel at the base. It is evidently a distinct species, without analogy to any other of the coal measures.

Habitat—Mazon Creek, Ill., in nodules; Cannelton, Pa., very rare.

ODONTOPTERIS SCHLOTHEIMII, *Brgt., Pl. XX, Figs. 1, 2.*

Filicites osmundæformis and F. vesicularis, Schloth., Petref., pp. 412 and 413. Flor. d. Vorw., Pl. III, f. 5; XIII, f. 26.

Odontopteris Schlotheimii, Brgt., Hist. d. veg. foss., p. 256, Pl. LXXVIII, f. 5. Goepp., Gatt., V, VI, p. 98, Pl. VI, f. 1, 5. Lesqx., Geol. of Penn'a, 1858, p. 860, Pl. VII, f. 1. Schp., Paleont. veget., I, p. 460.

Weissites vesicularis, Goepp., Syst., p. 14. Gein., Verst. d. Zechst., 1, p. 2, Pl. VIII, f. 8.

Frond bi-pinnate; primary divisions oblong-lanceolate, more enlarged in the middle; secondary pinnæ in right angle, or slightly oblique, pinnately divided in oval, obtuse pinnules or lobes, the lower ones nearly free, the others gradually smaller, more and more connate toward the apex, where they pass into a small deltoid or lanceolate obtuse terminal pinnule; veins parallel from the base, distinct and distant, forked above the middle.

This species is well known; however, no specimens have been figured until now, representing entire pinnæ like that of our plate. The parallel position of these pinnæ indicates them as primary subdivisions of a large frond. They vary from twenty to thirty centimeters long, even more, and are apparently in right angle to the main rachis. The secondary pinnæ, also in right angle, five to ten centimeters long in the middle, become shorter towards the base, and bear alternate leaflets, generally connate to the middle. Toward the upper part of the primary pinnæ, the lobes become connected in their whole length, and the secondary divisions pass into entire, oblong, obtuse pinnules, with a three or four lobed terminal leaflet. The veins are distant, parallel at the base, curving downwards to the rachis, or joining it in right angle, distinct, forking once. In the basilar leaflets, whose shape is generally round, the distribution of the veins is palmate from a central basilar point, as in *O. alpina.* The rachis of this species when flattened, is exactly linear, and distinctly striate, like a leaf of *Cordaites.* I have seen fragments of it, two and a half to three centimeters broad. F. 2, copied from Goepp., Gatt., l. c., represents inflated leaflets which, as said above, were considered formerly as fruiting parts of this species, but have been more recently recognized as casual deformations due probably to the action of some insects. A similar inflation is remarked on the borders of some pinnules of this species in specimens from Morris.

Habitat—Tremont new vein, in large specimens. Found also at the Tunnel vein, near the same place. St. Clairsville, Ohio, in a Coal equivalent of the Pittsburgh Vein, Mr. P. W. Emerson. More generally found in the upper strata of the middle coal measures, rarely in the lower. It has been obtained, however, by Mr. S. S. Strong, in the shale above the coal of Morris, Ill.

ODONTOPTERIS SUBCRENULATA, *Sp. nov.*, *Pl. XXI*, *Figs. 5, 6.*

O. crenulata, *Lesqx.*, *Geol. of Penn'a*, *1858*, *p. 860.*

Frond bi-pinnate; pinnæ linear-lanceolate; pinnules attached by the whole decurring base to the narrow rachis, disjointed, rhomboidal, obtuse or truncate, distinctly crenulate; veins all from the rachis, parallel at the base, forked from the middle, distant.

This species resembles *O. crenulata*, Brgt., Hist. d. veg. foss., p. 254, Pl. 78, f. 1–2, but differs by its shorter broadly obtuse leaflets, crenulate all around, not lanceolate, nor lobate or deeply crenate at the apex. The larger pinnules, f. 6, about one centimeter long and nearly as large, are broadly obtuse, some of them obliquely truncate and equally crenulate all around the borders. They are sessile by their whole base and decurrent, bordering the rachis by a narrow margin. In the upper part of the primary pinnæ, as seen f. 5, the secondary divisions gradually pass to simple, linear-lanceolate, obtuse pinnules, undulate on the borders by the gradual shortening of the lobes. They are distinctly crenate and decurring as in f. 6. Brongniart's species is closely related to *O. Brardii*, to which it is united by some authors; this one has its affinity to *O. Schlotheimii*, from which it essentially differs by the crenulate borders. I have seen a number of fragments of this plant, all from the same locality and with identical characters, the pinnules only being variable in size, according to the inferior or superior position of the pinnæ.

Habitat—The large specimen communicated by Mr. W. Lorenz, chief engineer of the Philadelphia and Reading R. R., is from Salem Vein, near Pottsville. The other is from the Tunnel Vein below Tremont, same horizon. Another fragment found there also, represented, Atl., Pl. XVI, f. 11, and described with *Neuropteris crenulata*, Brgt., has a great affinity to this species and may perhaps be referred to it.

ODONTOPTERIS ABBREVIATA, *Sp. nov., Pl. XXI, Fig. 7.*

Pinnately divided; pinnæ apparently open, parallel, close; pinnules alternate, oblong or sub-linear, obtuse, disconnected, rounded to the rachis and joined to it by a broad base; borders undulately lobed, but entire; costa broad, gradually thinning upwards and effaced below the point; veins diverging in an open angle from the midrib, slightly curving towards the borders, forked above the middle.

The leaflets, nearly equal, gradually, slightly shorter towards the top of the pinnæ, average one and a half centimeters long and eight millimeters broad, at their base. They preserve from the base to the top of the pinnæ (ten centimeters long) exactly the same form and size. Near the base, they are a little enlarged into one pair of more distinctly marked lobes, then upwards merely undulate and then gradually entire to the obtuse apex. The veins are distinct, twice as close as in *O. Schlotheimii*, to which the species is comparable, and generally inflated from the middle to the borders, Atl., f. 7*a*. The parallel position of the two branches indicates the fragment as detached from a primary pinna of large size.

Habitat—Pittston. Collection of Mr. R. D. Lacoe. Specimen No. 172, from Carbon Hill shaft, C vein.

ODONTOPTERIS SPHENOPTEROIDES, *Sp. nov.*, *Pl. XXI, Figs. 3–4.*

Bipinnate; secondary pinnæ lanceolate, joined by a narrow margin of the rachis, distant, pinnately deeply lobed; lobes triangular, acute, deeply crenate; veins distant at the base, more or less decurring, either all from the rachis and parallel at the base, or branching from a middle decurring nerve, forking once.

I have nothing of this species but the two fragments figured. By the narrow flat margin following the rachis and uniting the pinnæ; by the attachment of the veins of some of the lobes to a decurrent midrib, as seen f. 3, and by the direction of the veinlets, each to the point of the teeth, the species seem really referable to *Sphenopteris*. But in most of the sub divisions, especially in those of f. 4, and also in those of f. 3, when not very oblique, the emergence of the veins from the rachis is clearly marked. Comparing f. 3 to f. 2 of the same plate, a fragment doubtfully referable to *O. Brardii*, whose rachis is also flattened along the borders, whose veins are, some of them at least, joined to a more inflated medial one, representing a costa, the relation between the two species is evident. It would amount to identity, if the pinnules of f. 2 were crenulate. In both, the pinnæ are short, three to four centimeters, divided in about seven pairs of alternate lobes, more and more connate towards the acute terminal pinnules, and the lower is lobed on the inferior side.

Habitat—One of the specimens, communicated by Dr.

Britts, is from Clinton, Mo. The other, more distinct, is in a nodule from Mazon creek.

ODONTOPTERIS GRACILLIMA, *Newb'y.*

Geol. Rept. of Ohio, Paleont., I, p. 382, Pl. 46, f. 1-3.

Frond bipinnate; pinnæ close, long and narrow, parallel, open; pinnules short, rhomboidal, acute, confluent to the middle; veins strong, mostly three, attached to the rachis and parallel at the base, the central divided in three branches from the middle.

This species is remarkable by its narrow, very long, linear pinnæ, one of which, figured, is fifteen and a half centimeters long, seven millimeters broad in the middle, slightly and gradually narrower both toward the base and the apex. The species is not less remarkable by its nervation. Of the three veins, rarely four, which, parallel at the base, ascend in curving upwards towards the borders, the middle one, stronger in the lower part, divides in three branches near the middle, the two lateral branches being opposite, the medial one ascending to the acute and scythe-shaped point of the pinnules.

The author remarks that the fertile pinnæ are of the same form, only relatively narrower, and that the fructifications are somewhat different from those of *O. Schlotheimii*, the entire surface of the fronds being covered with sori.

This species is without relation to any other of the coal measures. It resembles, by its narrow, long pinnæ, *Alethopteris serrula*, Lesqx. Geol. of Penn'a, 1858, p. 865, Pl. XII, f. 1, but the divisions of the pinnules and the nervation are of a far different character.

Habitat—Coal No. 1, (sub-conglomerate,) Youngstown, Ohio.

SPECIES INSUFFICIENTLY KNOWN.

ODONTOPTERIS BRARDLEYI, *Lesqx.*

Geol. Rept. of Ill., IV, p. 390, Pl. VIII, f. 11.

Pinnately divided; pinnules distant, small, lanceolate-acuminate, rounded at the base and somewhat prolonged *on the inferior side, with a short, distinct pedicel; middle nerve either totally obsolete, or obscurely marked from the middle downward; veins thin, dichotomous, diverging towards the borders, distinct only under the removed epidermis.*

Until recently I had not seen any specimen which might elucidate this species, described from a single leaflet, not even preserved entire. Among the specimens communicated lately by Mr. F. W. Emerson, there is a fragment of a pinna, four and a half centimeters long, bearing six pairs of sub-opposite leaflets, the terminal one destroyed. It is from this pinna that the diagnosis is made. The pinnules are distant, lanceolate, sharply acuminate, obliquely truncate at the base, the superior basilar lobes being cut obliquely, and the lower ones prolonged in the same direction. The surface is covered by a coating of coaly matter, which obliterates the veins. The facies of the Fern is most like that of *Neuropteris acuminata*, Brgt.; but its leaflets are not half as large. I do not believe, however, that it represents a *Neuropteris*, at least the nervation, as far as it can be discerned through the epidermis, is of the same type as in the pinnule figured in the Ill. Rept., l. c. These fragments may, however, belong to two different species.

Habitat—Concretion of Mazon creek, a single leaflet.—Shale over the coal of St. Clairsville, Ohio, an upper coal. The distribution of the fragments in the upper and lower coal render their identily more doubtful.

ODONTOPTERIS DEFORMATA, *Sp. nov.*

Bi or tripinnate; primary pinnæ long, linear-lanceolate, narrow; secondary pinnæ short, sessile, linear-lanceolate; pinnules connate at the base only, becoming confluent near the top, small, five to six millimeters long, lanceolate, with a blunt apex; veins nearly straight, thin, parallel, or slightly diverging, dichotomous.

The specimens representing this species are deformed by contraction of the pinnules on one side, and expansion on the other, as is often the case with the vegetable remains of the anthracite of Rhode Island. The general characters agree with those of *O. Brardii.* The pinnules, however, are much smaller, of the same size about as those of *O. minor*, Brgt., and rather obtuse than acute. It is an intermediate form of uncertain relation, especially on account of the deformation of the remains.

Habitat—Mount Hope coal mines, near Newport, Rhode Island, communicated by Mr. Jas. H. Clark. The specimens from which the above diagnosis is made, are O. 17 and O. 57 of the collection of the Museum of Comp. Zool., Cambridge.

LESLEYA, *Lesqx.*

Pinnæ simple, very entire, sub-lanceolate, gradually narrowing towards the base, traversed by a thick costa effaced under the apex; veins oblique, curved, equal, repeatedly dichotomous.

This description is the exact translation of Brongniart's diagnosis of the Genus *Glossopteris*, with the omission of the last sentence, indicating the characters of the veins as *being sometimes anatomosing or reticulate.* On this Schimper remarks, Paleont. Veget. 1, p. 644, that Brongniart, in his *Tableau des genres*, considers the partial reticulation of the veins marked only near the middle nerve, as the essential character of this genus; but that the description of the nervation is not perfectly exact, as the anatomoses are not limited to the area bordering the rachis, but are seen too near the borders, where they become only more rare.

The leaves described here under the above generic name do not show any trace of anastomoses or reticulation of the veins, not even in their connection to the rachis. It would, therefore, be inappropriate to refer them to a group of plants whose essential character is different, and which represents only species of the Indian and Australian Carboniferous.

This genns is related by some of its characters to *Neuropteris* and by its venation of its fine species especially to *Megalopteris.*

LESLEYA GRANDIS, *Sp. nov.*, *Pl. XXV*, *Figs. 1–3.*

Leaves or pinnæ apparently simple, broadly lanceolate, obtusely pointed, largest in the middle, gradually narrowed to the base; borders entire or deeply split; nerve very thick, half round, thinning to near the point, where it is effaced by division; veins dichotomous, moderately curved in traversing the lamina, distinct.

The relation of this species, at least by its more marked characters, is with *Neuropteris*. Except for the strong round midrib, it should be referred to that genus. The three fragments figured, the only ones seen until now, indicate the leaf as simple and basilar. The largest, f. 1, finely preserved, is twenty-two centimeters long, eight centimeters broad in the middle, narrowed nearly in the same degree downward to the base, which seems to have been slightly decurrent, and upward to an obtuse apex. This leaf is entire, while that of f. 2, apparently in a more advanced state of decomposition, is more or less deeply split along the borders, thus divided in lobes or laciniæ of different size. This splitting indicating a thin texture of the laminæ, is probably casual and mechanical, though the base of the lacerations is in some places an obtuse, narrow sinus, such as could result from the separation of the lobes during the growth or development of the leaves. In any case, it cannot be considered as a normal character. Others and irregular erosions seen f. 1 and 3, have the borders also smooth, like the sinuses of f. 2.

The lateral veins, exactly represented, do not fork as repeatedly as in species of *Neuropteris*. They are more equal, less curved, slightly turning upwards near the borders, where they number twenty-five to thirty per centimeter.

Habitat—Soft shaly sandstone, base of the Chester Limestone. Communicated by Prof. A. H. Worthen.

DICTYOPTERIS, *Gutb.*

Frond bipinnate; pinnules cordate, truncate or rounded at the base, sessile or short pedicelled, oblong-obtuse or *lanceolate, entire; veins flexuous, connected by flexures and intersections, forming a more or less distinct and close reticulation of polygonal meshes.*

This genus is, like the former, intimately allied to *Neuropteris.* As seen from *Dictyopteris rubella*, Atl., Pl. XXIII, f. 7–10, the more common forms of species of *Neuropteris*, are represented in it, either by small oblong obtuse pinnules, f. 8, similar by size and shape, even by the short pedicel, to the lateral leaflets of *Neuropteris capitata*, f. 1, of the same plate; or by lanceolate pinnules, truncate at the point of attachment, with undulate borders like those of *Neuropteris gibbosa*, Atl., Pl. VI, f. 2, while the cyclopterid character is clearly seen in f. 10 of the same plate. The reticulation of the lateral veins is more or less close and distinct in the different species of *Dictyopteris*, but generally the veins may be followed in their direction towards the borders and the undulations seen coming close to each other, often without connection of the flexures. This character is represented for *D. Scheuchzeri*, in Roem., Paleont., VIII, Pl. XXI, f. 12. I have given also an enlarged figure of the same distribution of the veins of *D. rubella*, in Rept. of Ill., l. c. Sometimes indeed the undulations of the veins are short and joined at their angles, and the veinlets pass across either above or under them, and thus multiply the meshes. It is the case in *D. obliqua.* But I have not seen any real anastomosing of the veins, even upon specimens of the species, and really the affinity of venation between *Dictyopteris and Neuropteris* species is so great that, as remarked in the description of *N. Loschii*, some leaflets representing *Dictyopteris* by the reticulation of the veins, are intermixed upon the same pinna with others positively referable to *N. Loschii*, by their venation. Roemer regards his *D. cordata* as identical with *Neuropteris cordata*, Brgt., a mistake probably, caused by considering as veinlets the hairs attached to the lower surface of some *Neuropteris*, like *N. cordata*, or *N. decipiens*, which, often close and thick, stamp the counter-impressions upon the shale by linear grooves similar to those of anastomosing veinlets. Brongniart, in his Tableau des genres, remarks the relation of this genus to *Neuropteris.* Gutbier, its author, places it after *Neuropteris*, mentioning, however, the affinity of the venation to that of *Lonchopteris.* Schimper in his Handbuch der paleont., 1879, separates the *Dictyopterids* as a sub-group of the *Neuropterids*, under the name of *Dictyoneuropterids*, while he admits in *Dictyopteris* the Ferns only whose areolation is composed by true anastomosis of the veins, like *Camptopteris*, *Dictycophyllum Clathropteris*, etc.

DICTYOPTERIS RUBELLA, *Lesqx.*, *Pl. XXIII, Figs. 7–10.*

Geol. Rept. of Ill., IV, p. 388, Pl. VII, f. 2–6. Schp., Paleont. Veget., III, p. 514.

Frond bi or tripinnate; pinnæ linear-lanceolate; pinnules open, either cyclopterids, large, sessile, deeply cordate-auriculate; or of middle size, distant, lanceolate, obtusely acuminate, sub-truncate, or abruptly rounded at base, to a short enlarged petiole; or, as tertiary leaflets, small oblong-obtuse; midrib basilar or none; veins dichotomous and flabellate from the base, arched towards the borders, irregularly undulating, and forming, by contact of the flexures, rhomboid-oval reticulations.

The specimens figured represent the three more distinct forms of this specie, relating it, as said above, to species of *Neuropteris* from which it differs only by the reticulation resulting from the undulation of the veins. F. 10 is a *Cyclopteris* with a deeply cordate-auricled base, indicating its attachment either to a primary rachis or to the point of division of the pinnæ. F. 9 has leaflets four and a half centimeters long, one and a half centimeters broad at the truncate or rounded base, similar to those of *Neuropteris vermicularis* and other species. They are only more distinctly scythe-shaped. This character seen upon the pinnules of other species of *Dictyopteris* is not marked on those of the tertiary pinna, f. 8, whose oblong-obtuse leaflets, a little longer than one centimeter, are slightly contracted in the middle, resembling those of *Neuropteris* *tenuifolia.* The reticulation is formed by contact or merely by the approach of the flexures of the undulating veins, which become free and separated towards the borders.

As remarked in the first description of this species, Geol. Rept. of Ill., l. c., the epidermis or the substance of the pinnules has become, by maceration, easily separable from the stone in thin lamellæ. Whole pinnules have been obtained in that way, without any earthy substance adhering to them and half pellucid, showing the disposition of the veins clearly exposed by microscopical examination. An enlarged representation of the venation as seen through the microscope, Pl. VIII, f. 6, l. c. could not be given on our plate from want of space. The peculiar red color of the epidermis and its easy separation from the stone, in all the specimens obtained, prove their reference to the same species. They were moreover all cut from the same block of shale.

Habitat—Murphysborough, Ill., low coal.

DICTYOPTERIS OBLIQUA, *Bunb'y., Pl. XXIII, Figs. 4–6.*

Bunb'y., Coal Form. of Cape Breton, Quart. Journ., III, p. 427, Pl. XXII, f. 2. Lesqx., Geol. of Penn'a., 1858, p. 861 (excl. Pl. VIII, f. 6). Geol. Rept. of Arks., p. 313, Pl. V, f. 10. Schp., Paleont. Veget., 1, p. 618.

Frond bi-pinnate; pinnæ linear; pinnules linear or oblong-obtuse, more or less distinctly scythe-shaped, subcordate at base; veins closely reticulate.

The pinnules of this species, attached to a narrow rachis by the base of the costa only, are very deciduous and generally found scattered and free from the rachis, though sometimes extremely numerous. The leaflets, one to two centimeters long, six to seven millimeters broad, are a little more prolonged on one side of the base, according to their direction. For though generally in right angle to the rachis, they incline either upwards or downwards and the enlarging of the base of the leaflets is opposite to that inclination, as seen on the branch f. 6. The leaflets vary in size merely, and this, even comparatively little; for the smallest I have seen, figured in Arks. Rept., l. c., is one centimeter long and half as broad. The reticulation of the veins is always close and distinct; the costa, distinct to above the middle, is formed by the prolongation and close apposition of the base of the lateral veins, as seen f. 5.

In Geol. of Penn'a, 1858, I referred to this species and there figured, Pl. VIII, f. 6, a fragment which does not seem to belong to it. The venation is somewhat similar or reticulate by the undulation of the veins; but as I have observed the same character in leaflets of species of *Odontopteris* and *Neuropteris*, I now consider this fragment referable to *O. Schlotheimii.*

Habitat—The whole extent of the coal measures from the sub-conglomerate to the upper beds of the middle coal, the Pittsburgh and St. Clairsville veins. It is also present through the whole area of the coal fields. Abounds at Trevorton where I have found a stratum of shale so thickly intermixed with leaflets of this species that it appeared as merely composed of them; also at the Salem vein, near Pottsville. Rare in the sub-conglomerate coal of Arkansas; more abundant in the nodules of Mazon creek, Ill.; in the shale of Cannelton, Pittston, Wilkesbarre, Pa.; at Clinton, Mo.; also in the coal of Rhode Island, etc.

FERNS OF UNCERTAIN RELATION.

In this group I place the genera *Megalopteris*, Daws., related to *Neuropteris* by the nervation and to *Alethopteris* by the position of the leaflets, decurring on the rachis; *Tæniopteris*, Brgt., which is diversely considered by the authors in regard to place and affinity; *Neriopteris*, Newb'y; *Danæites*, Goepp.; *Orthogoniopteris*, Andrews, and *Protoblechnum*, Lesqx., whose relation to the two first of the above genera is considered in the descriptions. I place in this group also a remarkable leaf, *Idiophyllum*, related by its general character to *Phlebopteris* (*Dictyophyllum*) *Nilsoni*, Brgt., and by its peculiar nervation to *Dictyopteris.*

MEGALOPTERIS, *Daws.*

Fronds very large, simply pinnate; ultimate pinnæ (or pinnules) oblique, sublinear or lanceolate, entire, the lower *side broadly decurrent on the rachis, which thus becomes alate, the upper narrowed in a curve, confluent; midrib thick; canuliculate on the upper surface, half cylindrical on the lower, gradually narrowed but distinct to the apex of the leaves; veins open, emerging from the rachis in a more open angle of divergence, curving upwards in reaching the borders, close, dichotomous.*

Except for the characters of the venation, this genus is not separable from *Danæopsis*, Heer. The veins are more oblique, much thinner, dichotomous, generally forking once near the base, and one of the branches or both forking again near the border.

MEGALOPTERIS SOUTHWELLII, *Sp. nov., Pl. XXIV, Fig. 1.*

Frond very large; rachis half round; pinnules linear or oblong, abruptly rounded to a short acumen; costa very thick, continuous, veins open, curved down in joining the rachis and inclined upwards towards the borders, dichotomous, thin, close, distinct.

This species is indeed a magnificent one, by the size of the pinnæ of which a small fragment only could be figured. The sketch of part of one of the largest, made in place by Mr. Southwell, who discovered the remains, is eleven and a half centimeters broad, about in the middle, with a half round costa, twelve millimeters thick. Another sketch of the terminal portion of a pinna shows the upper leaflets seventeen centimeters long from the base of the midrib to the apex and only three centimeters broad. According to this, and by comparison, the largest leaflets should have measured fifty to sixty centimeters in length. It is not surprising that notwithstanding active researches this plant could be obtained only in fragments. The upper pinnæ are disposed about like those of f. 2, the main rachis becoming gradually narrower, passing up to the apex of a terminal pinnule of same form and size as the lateral ones. The lateral veins are gradually in a more open angle of divergence to the rachis, in descending towards the base of the leaflets, and thus are nearly in right angle upon the decurrent base which tapers downwards to the point of connection with the upper border of the inferior pinnule, joining it quite near the rachis.

Habitat—Lower beds of the Coal Measures, sub-conglomerate, near Port Byron, Ill., Mr. J. H. Southwell.

MEGALOPTERIS HARTII, *Andrews.*

Geol. Rept. of Ohio, Paleont., II, p. 416, Pl. XLVI, f. 1.

Ultimate pinnæ alternate, oblique, linear-lanceolate, obtuse, broadly decurrent; medial nerve flat, dissolved below the apex; veins numerous and fine, in an acute angle of divergence, dichotomous, curved in passing to the borders.

From the former species this one evidently differs by the obtuse leaflets, the flat midrib and the lateral veins in a more acute angle of divergence. The average size of the pinnules is one and a half centimeters wide and ten centimeters long; the terminal leaflet is shorter and narrower. The author describes the margin of this species as some times distantly and irregularly crenate. This is probably a casual appearance caused by laceration or maceration of the borders as in all the species known until now the margins are positively entire.

Habitat—Base of the coal measures near Rushville, Ohio. Discovered by the author, with all the other specimens described from that locality.

MEGALOPTERIS MINIMA, *Andrews.*

Geol. Rept. of Ohio, Paleont., II, p. 416, Pl. XLVIII, f. 1-3.

Pinnules smaller, lanceolate, obtusely acuminate; veins more open and less numerous.

Except that the size of the fronds and pinnæ is smaller, the species has about the same characters as the former; the veins are only more open, more distant and distinct.

Habitat—Same as the former.

MEGALOPTERIS OVATA, *Andrews.*

Geol. Rept. of Ohio, Paleont., II, p. 417, Pl. XLVII, f. 1, 2.

Pinnules short, ovate, or broadly lanceolate, obtuse; venation same as in the former species.

The pinnules are broader and comparatively shorter. It is the essential difference which separates this form from *M. minima.* The author remarks that in the decurrent laminæ, the veins become more open and nearly in right angle to the rachis. This character is observable upon all the species of this genus. It results from the deviation of the decurring borders from the normal line. In unequilateral pinnæ, as in those of *M. abbreviata*, the angle of divergence is different upon each side of the pinnules.

Habitat—Same as the former species.

MEGALOPTERIS FASCICULATA, *Sp. nov.*, *Pl. XXIV, Fig. 2.*

Pinnules comparatively small, lanceolate, equally narrowed to the acuminate point and to the decurring base; midrib narrow, continuous; lateral veins on an acute angle of divergence, distinctly curved upwards in reaching the borders, more distant and thicker than in M. Southwellii.

This fine fragment appears to represent a young frond preserved in its integrity. The lower pinnules are like fasciculate, or two or three-lobed by forking of the medial nerve at their base, a division very similar to that of *Neuropteris fasciculata*, f. 6, of the same plate. These lower pinnules are not decurrent, but the rachis becomes winged, and its borders veined lengthwise by parallel fascicles of vessels derived from the central axis, as in the basilar stalks of some fronds.

This species differs already from *M. Southwellii* by the venation; for according to the remarks of the discoverer, the veins in this last species become more distant proportionally to the size of the leaves, hence the greater distance of the veins on small pinnules, like those of this Fern, should already authorize a specific separation. But there is also a marked difference in the size of the pinnules and in their form; for in this species, the leaflets are truly lanceolate, gradually narrowed to a sharp and long acumen, while in *M. Southwellii*, the pinnules are linear, narrowed in rounding to a very short point.

Habitat—Lower beds of the coal measures of Ills., Mr. I. H. Southwell.

MEGALOPTERIS ABBREVIATA, *Sp. nov. Pl. XXIV, Fig. 3.*

Pinnæ ovate, rapidly narrowed and rounded to the apex, broadly decurrent; midrib narrow; veins thin, close, dichotomous and distinct.

Comparing also this species with *M. Southwellii*, it differs by the size and shape of the pinnules, which, much shorter, are ovate, narrowed to a short acumen. The midrib is narrower; the venation is of the same character.

Habitat—With the former.

MEGALOPTERIS LATA, *Andrews*

Geol. Rept. of Ohio, Paleont., II, p. 417, Pl. XLVII, f. 3, 3a.

Pinnules large, sometimes bifurcate above the middle by the splitting of the medial nerve, veins less curved than in the former species.

The author, comparing this form to *M. Dawsoni*, Hart, Acad. Geol., 2*d*, Ed., p. 550, remarks that it differs by the surface not rugose, the veins less divided and less curved.

In the number of species described above we have, it seems, two peculiar types, especially differing by the size of the midrib. It may be, however, that the specimens obtained from Illinois represent the under surface of the leaflets, with a half round large costa, while those obtained in Ohio show the upper surface with the medial nerve flattened. Of *M. Dawsoni*, Hart, the author, says that the midrib is thick, and shows a strong tendency to split up obliquely to the rachis. From the figures, however, the midrib is very thin, indeed not marked at all. The general characters of the species described either by Prof. Andrews, from Ohio specimens, or by myself, from fragments received from Mr. Southwell, appear remarkably similar in each peculiar group. Adding this to the uncertainty about the exact conformation of the midrib, it would not be amiss to suppose that we have here only two species, represented each by the specimens of the two localities, the fragments under divers forms and size, being referable to the various parts of the plants; some to old fully unfolded fronds; others to young and basilar ones.

Though it may be, in regard to the specification of the fragments, it is certain that they pertain to a group of ferns which, at the beginning of the carboniferous epoch, represents this family by plants as remarkable by their magnitude as by the elegance and the beauty of their forms. No types in the successive developments of the vegetation of the Ferns of the coal seem comparable to that of the *Lesleya* and the *Megalopteris*.

MEGALOPTERIS? MARGINATA, *Sp. nov. Pl. XXIV, Fig. 4.*

Pinnules fasciculate at the top of the fronds, lanceolate, acuminate, gradually narrowed downward; borders reflexed; medial nerve narrow, but thick and distinct, precurrent; veins oblique, distant, forking twice, moderately curved in passing to the borders.

The only specimen received of this species is figured. It represents the upper part of a pinna or of a frond with four pinnules, whose base is destroyed. They occupy the same position as those of f. 2, of the same plate, and from their direction towards a common axis, they appear to be joined to the rachis, like the divisions of the fronds of *Megalopteris;* for the shape of these leaflets and the venation are also of analogous character. The pinnules, larger above the middle, are narrowed to a short, slightly truncate acumen, formed by the prolongation of a thick costa beyond the borders, which, reflexed as they are, do not entirely cover its top. The duplication of the borders is much like the marginal folding, covering the fructifications of some Ferns of our time—*Pteris*, *Pellæa*, etc. It is, however, more regular, and though the doubled borders can be separated in fragments, they do not seem to cover any fruiting organs; at least, close and repeated examinations have failed to show under them any trace of sporanges, but merely fragments of a very thin pellucid, narrow membrane. The marginal mode of fructification, if positively ascertained, would refer these Ferns to *Alethopteris*, a genus to which *Megalopteris* is related also by the decurring base of the pinnules, forming prolonged wings along the rachis.

The substance of the leaves of this species is comparatively thick; the veins distant, more oblique still than in *M. fascieulata;* the pinnules are also shorter and broader. However, the facies of the remains representing these two forms is so much alike, that, if any trace of fructifications had been observed, I should have considered the fragments as referable to the same species, for there is often an appreciable difference in the characters, venation, sub-divisions of the pinnules, etc., between the sterile and fertile fronds of the same kind of Ferns.

Habitat—Lower carboniferous near Port Byron, Ill. Mr. Southwell.

TÆNIOPTERIS, *Brgt.*

Fronds simple, large, linear; medial nerve (raehis) canalieulate, strong; veins open, or in right angle, thin, forking a little above the base or more generally simple, parallel, sometimes joined to a marginat nerve; fructifications unknown.

The species formerly admitted in this genus by authors are distributed now, Schp., Paleont. veget., I, p. 600, in the Genera *Tæniopteris*, for species of the Permian and Permo-Carboniferous; *Angiopteridium*, Schp., for those of the Jurassic, mostly of East India; *Marattiopsis*, Schp., for one only, tertiary; *Oleandridium*, Schp., for triasic and tertiary species; *Maerotæniopteris*, for those of the Lias and Oolithe, some of them also Australian and East Indian; and *Danæopsis*, Heer, for two Triassic plants. From this it appears that no species of *Tæniopteris* has been found until now in the true carboniferous measures, or below the New-red (Permo-Carboniferous.)

TÆNIOPTERIS SMITHII, *Lesqx., Pl. XXV, Fig. 7.*

Geol. Rept. of Ala., 1875, p. 78 (mentioned).

Fronds simple, large, linear; midrib broad, canalieu-

late in the middle, flat on the borders; veins in right angle, very thin and close, distinct, parallel, mostly simple.

A fine and remarkable species known only by the fragment figured. The width of the leaf, nearly five centimeters broad, indicates its length at fifteen centimeters. The fragment is nearly linear, a little more enlarged toward the lower part; the borders are perfectly entire, slightly inflated as by a marginal nerve, lacerated only by maceration and erosion; the substance is thin. The veins are in right angle to the broad midrib or rachis, mostly simple, rarely forking once near the base, three to four per millimeter, contiguous, scarcely varying in their horizontal direction from the point of attachment to the border.

T. multinervis, Weiss., (*T. carbonaria*, Schp.), has some affinity to this Fern. The veins of the European species are more distant, distinctly curved down to the rachis, more divided, and the costa or rachis not channeled.

Habitat—Sub-conglomerate measures of Alabama. Locality not indicated. The specimens sent for determination by Prof. Eug. A. Smith were without labels. But except a few fragments of *Lepidodendron* from the Anthracite of Wilkesbarre, all the others were positively from the Alabama coal fields. The stone whereupon this leaf is preserved is of the same nature and compound as that of a number of other specimens from Helena coal mines.

NERIOPTERIS, *Newb'y.*

Geol. Rept. of Ohio, Paleont., I, p. 378.

Frond pinnate or bi-pinnate; rachis strong, punctate; pinnules lanceolate, simple, entire; medial nerve strong, extending from base to summit; secondary veins given off at an acute angle, numerous, simple or forked at the base, parallel, equal; fructifications marginal.

NERIOPTERIS LANCEOLATA, *Newby.*

Geol. Rept. of Ohio, I, p. 381, Pl. XLV, f. 1–3.

Frond pinnate or bi-pinnate; pinnutes diverging from the rachis at an acute angle, lanceolate, acute, rounded to *the point of attachment, sessile or short petioled; midrib strong, straight, percurrent; veins coming out from the rachis at an acute angle of divergence, slightly curved at the base, crowded, simple or forked near the base, parallel and equal.*

The author says of this species, that it is, by some of its characters, similar to *Phyllopteris antiqua*, Daws. Acad. Geol., 2d Ed., p. 484, f. 166 E, differing by the nervation which in the Ohio species has an equal degree of affinity to *Alethopteris* and *Tæniopteris*. Comparing the upper part of the pinnules, as figured by the author, to the fragment of Atl., Pl. XXIV, f. 4, the similarity of shape is striking; the flexure of the borders is the same, the leaflets are only more distinctly acuminate in this last figure. The affinity is eliminated by the great difference in the venation which in our plant is of the *Megalopteris* type, while from the figure of Dr. Newberry, the veins are straight, simple, though slightly oblique and parallel. The author remarks that the enlarging f. 3, does not correctly represent the venation, the veins being forked at the base and somewhat curved at their point of junction to the rachis. Even with this correction, the venation of both species seems of a different character; for indeed, that of *Megalopteris fasciculata* is positively of the same type as in the other described forms of the genus, while Dr. Newberry compares the venation of his species to that of *Tæniopteris*. As the base and mode of attachment of the leaflets of *M. fasciculata* is not known, a definite comparison of these two plants cannot be made.

Habitat—Base of the coal measures. Coal No. 1, of Summit Co., Ohio. Discovered by the author.

ORTHOGONIOPTERIS, *Andrews*.

Geol. Rept. of Ohio, Paleont., II, p. 418.

Frond simply pinnate; pinnules alternate, lanceolate or oblong-linear, rounded and tapering to an acute point, enlarged and decurrent on the lower side to an auricle rounded in the upper part in joining the lamina a little above its point of attachment to the rachis; medial nerve *thick, ascending to the apex; nervules fine and numerous, uniform, at right angle to the midrib, decurring to it at the point of attachment, forking once near the base.*

From the remarks of the author, this genus is allied to *Tæniopteris*, Brgt., *Angiopteridum*, Schp., and *Neriopteris*, Newb'y, having more the character of *Danæa* than any of the Pecopterids of the coal measures. It is however allied to *Alethopteris* by the decurrent base of the leaflets.

ORTHOGONIOPTERIS CLARA, *Andrews.*

Geol. Rept. of Ohio, Paleont., II, p. 419, Pl. L, f. 1, 1a.

Specific characters same as those of the genus.

This fine Fern is represented by two fragments of a same pinna thirty-seven centimeters long, linear obtuse in outline. The pinnules diverging from the rachis at an angle of 25°, are nine to eleven centimeters long, two centimeters wide, parallel, close, imbricated on the borders, linear to near the top where they taper in a curve to a more or less definite point; borders undulate or slightly revolute; nervation of the genus.

Habitat—Base of the Coal measures in Perry county, near Rushville, Ohio.

ORTHOGONIOPTERIS GILBERTI, *Andrews.*

Geol. Rept. of Ohio, Paleont., II, p. 420, Pl. L, f. 2.

Character of genus.

Differs from the preceding by a relatively stronger rachis, the pinnæ of a thicker substance, shorter, lanceolate, more distant; the medial nerve not as thick and the veins fine, closer, less curved toward the margin which is somewhat thickened. The pinnules are about six centimeters long, fifteen millimeters broad.

Habitat—Same as the former.

DANÆITES, *Goepp.*

Fronds pinnate; secondary veins coming out in right angle from the primary straight nerve, simple or dicho-

tomous; sporanges on the lower side of the lamina, placed in rows from the medial nerve to near the borders along the lateral veins, oval or linear, exannulate.

From the definition of the genus as admitted by Schimper, the fronds of the *Danæites* are merely pinnate, as they are also in all the living species of *Danæa.* Goeppert however, Syst., p. 380, Pl. XIX, f. 4, 5, describes as *Danæites asplenioides*, a species whose frond is at least bi-pinnate and whose sub-divisions are evidently Pecopterid This species, by its fructifications, does not appear related to *Danæa*, the sporanges being merely oval, placed near the midrib, and not distinctly in continuous rows as they are in living Ferns of the genus. *Danæites Schlotheimii*, Deb. and Ett., Acrob. d. Keide., p. 22, Pl. III, f. 1, a Cretaceous plant, has a marked relation to species of *Danæa* by its simply pinnate fronds, its fructification and the venation, and *D. firmus*, Heer., Fl. Arct., I, p. 81, Pl. XLIV, f. 20–22, also Cretaceous, has its fronds pinnate or bi-pinnate and its fructifications marked by a group of oval sporanges in juxtaposition to the midrib. In two of the *Danæites*, therefore, there is a difference in the characters of the sporanges and also in the divisions of the fronds from the general type as known from living Ferns. Considering that the species described here, has by its fructification a remarkable concordance of character with those of the species of *Danæa* of our time, its placement into this genus seems legitimate, though the frond is at least tripinnate, not simple. By this character and by the venation this plant is related to *Callipteridium* or to *Alethopteris.*

DANÆITES EMERSONI, *Sp. nov., Pl. XXVIII, Fig. 1–3.*

Frond very large, tripinnate; primary pinnæ lanceolate; secondary divisions linear-lanceolate, variable in length becoming gradually shorter toward the apex; pinnules oblong, very obtuse, connate near the base, the upper ones to the middle, in joining the terminal ovate obtuse leaflet; midrib thick, abruptly effaced near the apex; veins slightly oblique, simple or forking once, strong and close;

fructifications in linear series of sporanges passing in an upward curve from the midrib to the entire borders.

The substance of this Fern is coriaceous; the surface is a thick epidermis, covering and partly obliterating the venation which is distinctly seen only where this epidermis is erased. The general facies of the plant is that of an *Alethopteris.* Indeed by the division and forms of the leaflets, it has the greatest affinity to *A. Serlii* and to *Callipteridium Sullivantii.* F. 2 is part of a large specimen, thirty centimeters long, with broad rachis, one centimeter at the base, bearing alternate, sub-linear pinnæ, the lower ones fertile, longest in the middle, eight centimeters, gradually shorter downwards, the upper ones sterile also gradually shorter, becoming simple pinnules towards the apex as in all the species of *Alethopterids.* The specimen is a counterpart of the lower side of the pinnæ, deeply impressed into the stone, the fructifications being partly left attached to the matter in continuous, linear, somewhat broad rows of sporanges, covered by the thick epidermis, which, when removed, leaves the stone marked as f. *2a.* The intervals between the pointed lines separate the series of agglomerated sporanges, distinct on the borders of the linear zones by points or small indentations, as seen on the pinnules of the left side of f. *2a.* The form of the pinnules is the same in the fertile as in the sterile pinnæ; they are oblong, very entire, obtuse, variable in length and width, according to their position, the largest one in f. 1, being two centimeters near the base of the pinnæ, gradually shorter to eight millimeters under the terminal leaflets. The veins are thick, parallel and very close, as joined to each other along the borders, simple or forking near the base; no trace of veins is discernible upon the fertile leaflets.

Habitat—Shale above the Coal of St. Clairsville, equivalent of the Pittsburgh bed. Communicated in numerous specimens by Mr. P. W. Emerson of that place.

Danæites macrophyllus, (*Newb'y,*) *Lesqx., Pl. XXV, Figs. 4–6.*

Alethopteris macrophylla, Newb'y, Geol. Rept. of Ohio, Paleont., I, p. 383, Pl. XLVIII, f. 3, 3a.

Frond pinnate; pinnæ or pinnules sublinear, narrowed into a deltoid slightly obtuse apex; borders undulate or irregularly scalloped; base obliquely deeply cordate; medial nerve straight; lateral veins in right angle to the costa, scarcely curved downward in reaching it, crowded and numerous, very fine, simple or forking once.

This definition is that of Dr. Newberry, with scarcely any modifications, and agrees so well with the characters of the fragments represented in our plate that it is not possible to doubt identity, the only difference being that the Ohio leaves are slightly reflexed on the borders, while they are flat in ours. The veins are so fine, so exactly in right angle to the midrib, and so little divided, that at first sight the plant seems referable to *Tæniopteris.* But in this genus, the fronds or pinnæ are simple, while the shape of the base of the pinnules indicates those of this species as evidently pinnate. Its relation to the *Alethopterids* is contradicted by the unequal, deeply cordate base of the leaflets, a character which is not seen in any of the pinnules of this group; and also by the large size of the leaves and their nervation, the fragments indicating ultimate pinnæ ten to twelve centimeters long, and two to two and a half centimeters broad. Their lamina is irregularly scalloped or cut on the borders, as the leaves of some species of *Tæniopteris.* By the large size of the leaflets, and by their venation, this fossil Fern is related to *Danæa.* Some species of this genus bear simple pinnæ, prolonged at the base into an obtuse auricle, as in the fragment, Atl., f. 4.

Habitat—Youngstown low coal, No. 1 of the Ohio Geol. Rept.; same horizon as Talmadge, the locality where Dr. Newberry obtained his specimens,

Idiophyllum, *Lesqx.*

Leaves small, round, or broadly obovate; medial nerve *thick, gradually narrowed and effacing in joining the borders; lateral secondary veins sub-opposite, thick, passing in an inside curve towards the borders, gradually effaced in the reticulation; venules more or less continuous; sometimes crossing each other in contrary directions, and forming, by intersections, regularly quadrate or rhomboidal meshes.*

The leaf, the only one for which the genus is established, is, by its peculiar areolation, related to *Dictyophyllum*, Ll. & Hutt., and might be described under this name, but for the pinnate character of the leaves of all the specie referred to this last division. The English authors remark that the name *Dictyophyllum*, may be advantage-ously employed for the description of fragments of doubtful character referred to Ferns, leaving that of *Phyllites* for those positively dicotyledonous; and that other names may be invented for plants showing remarkable peculiarities in the arrangement of the veins, etc.

The only fragment figured to which this leaf may be compared, is that in St., Fl. d. Vorw., 1, Pl. XLII, f. 3, which, with f. 2, named *Phillites*, pertain to the lower Lias of Hoer, Scandinavia. F. 2 is referred by Schimper to *Dictyophyllum Nillsoni*, and is evidently part of a pinnate-lobate leaf; f. 3 is not mentioned or described anywhere. It shows only one side, the half of an oval entire leaf, with secondary veins oblique, parallel, and close. The strong nervules, about as distant as the veins, are in right angle and simple, passing parallel through the areas between the veins, forming a large quadrate areolation. I think that it would be advisable to refer Sternberg's plant to the same generic division; for the nervation is like that of our leaf, and if the mostly destroyed side had the same character as the preserved part, the whole would represent an oval, entire leaf, and the generic relation would then be confirmed.

IDIOPHYLLUM ROTUNDIFOLIUM, *Pl. XXIII, Fig. 11.*

Pinnule nearly round, more enlarged at the very obtuse nearly truncate apex; borders entire, nervation as described for the genus.

The leaf, attached to a rachis by its rounded base, or by the thickened base of the costa, is four centimeters long, four and a half centimeters broad in the upper part, where it is somewhat shrunk by compression of the upper border into the stone. The characters of the secondary veins indicate it as entire all around, the primary nerve becoming gradually thinner to near the border, where it is effaced; and the lateral, parallel, secondary veins (four pairs) curved upwards, being also gradually narrowed, and effacing close to the border in the same manner as the midrib. The tertiary divisions are real nervilles, though, by their direction, they appear as branches of the lower secondary veins. They are parallel, thick, generally continuous, passing over the secondary nerves, or sometimes curving back, and re-crossing the areas in a contrary direction, thus composing regular quadrangular, or broadly rhomboidal meshes, as seen on the left side of the figure. The peculiar character of the venation seems, therefore, more intimately related to that of the fragments f. 3, Pl. XLII, of St., l. c., than to any of the species of *Phlebopteris* or *Dictyophyllum* described by the authors. At first sight the likeness of this fossil fragment to some dicotyledonous leaves is striking. None of the Ferns of our time have any relation to it. The large meshes, either simple or double by the crossing of the nervilles, do not show any trace of intermediate areolation like that observed in *Clathropteris*.

Habitat—Mazon creek in nodules, lowest strata of the middle coal measures, close upon the Millstone Grit; communicated by Mr. S. S. Strong. The preservation of this leaf, that of species of *Spirangium*, and of a number of other vegetable remains never seen anywhere else in the Coal measures of this continent or of Europe, seem to prove that a large number of the plants of the Coal measures, those of a thin substance, easily destroyed by maceration, have, as yet, escaped research, and that a limited portion only of the remarkably rich flora of the coal is known to botanists.

ALETHOPTERIDS.

To this group, intermediate between the *Neuropterids* and *Pecopterids*, are referred the genera *Lescuropteris*, *Callipteridium*, *Alethopteris* and *Protoblechnum*.

LESCUROPTERIS, *Schimp., Paleont. Veget. 1, p. 465.*

Fronds large, bi, tripinnate; rachis broad, foliate; pinnæ pinnatifid, close, oblique; divisions ovate, acute, inclined outside, connate to the middle, decurrent to the rachis; primary nerve thin, dichotomous; lower pairs of lateral veins emerging from the rachis, the other alternately from the midrib, forking twice, the upper forking once or simple.

This genus, related to *Odontopteris* by the mode of attachment of the lateral veins, and to *Neuropteris* by their direction is, according to Schimper's remarks, distinguished at first sight from all the Ferns of the Carboniferous by its peculiar nervation. He compares the species on which the genus is established to *Odontopteris alpina*, and says that, from the distribution of the veins, it might be referred to the same division.

LESCUROPTERIS MOORII, *Schp., Pl. XXVI, Fig. 1, 1a.*

Neuropteris Moorii, Lesqx., Boston Journ., S. N. H., v. VI, p. 419. Geol. of Penn'a, 1858, p. 860, pl. XIX, f. 1.

The specific characters are those of the genus.

The thick rachis, obscurely striate, is winged by the interposition of half round leaflets between the base of the sessile decurrent pinnæ, joined to the rachis by the enlarged base of the lower pinnules, or by small, irregular subdivisions. The pinnæ, in an open angle of divergence, are long, ten to twelve centimeters, nearly one and a half centimeters broad in the middle, a little narrower near the base, also gradually narrowing to a terminal oval, very small leaflet, scarcely two millimeters long, and half as broad. The broad secondary rachis, two millimeters at its base, is still half as thick near the top of the pinnæ. The scythe-shaped acute pinnules resemble those of *Odontopteris Brardii;* they are, however, shorter, with a less acuminate apex. As in the last species, they are also sometimes obtuse. The epidermis, of a reddish color, becomes transparent when humected, and the veins, then more distinct, look as if traced in black. This character, which shows the membraneous texture of the pinnules, the alate rachis and the venation indicate close relation of this plant to *Callipteridium*.

Habitat—The locality indicated in the Geol. of Penn'a, l. c., was not precise. Mr. W. D. Moore, of Pittsburgh, to whom I owe the specimen, had received it without label. He believed that it had been obtained from a bed of clay overlying the Pittsburgh coal, at Irwin station, Pa. I saw later a few fragmentary specimens, also without labels, in the cabinet of Prof. E. B. Andrews. Some months ago I received, from Mr. T. W. Emerson, another specimen of the same size and character as the one figured, obtained in the roof shale of the coal of St. Clairsville, Belmount county, Ohio, which is considered as the equivalent of the Pittsburgh coal.

LESCUROPTERIS ADIANTITES, *Lesqx., Pl. XXVI, Fig. 4.*

Neuropteris adiantites*, *Lesqx.*, *Boston Journ.*, *S. N. H.*, *v. VI*, *p. 419.* *Geol. of Penn'a*, *p. 860*, *Pl. XX* , *f. 1.

Frond bipinnate; primary pinnæ deltoid in outline; secondary divisions linear-lanceolate, obtuse; pinnules or lobes connate to the middle, becoming confluent upwards in passing into an oblong obtuse terminal leaflet; midrib thin; veins oblique, forking near the borders; rachis alate.

Nothing is known of this Fern but the fragment figured. The species is distinctly related to *L. Moorii* by the decurring lower pinnules, which become attached to the main rachis; but differs by the very narrow rachis of the pinnæ, by the downward inclination of the midrib and of the lateral veins, forking merely once. Except the narrow rachis the affinity of the characters even in the nervation is close, as the lower lateral veins, sometimes at least are derived from the main rachis and the difference in the forking of the veins is, accountable to the small size of the half round very obtuse and oblique pinnules. The texture of the leaflets is membranaceous, like that of *L. Moorii*, but thinner;

the venation is distinct through the epidermis, when the surface is humected.

Habitat—South Salem vein, Pottsville. The geological horizon of this station is probably equivalent to that of the former species.

CALLIPTERIDIUM, *Weiss.*

Fronds large, polypinnate; pinnules attached to the rachis by the whole base, often decurrent and the lower descending to the main rachis, connate or disjointed at the base; primary nerve strong, dissolved below the apex; lateral veins oblique, curved in passing to the borders, dichotomous, the basilar attached to the rachis.

Limited as it is here, this genus admits species which, formerly referred to *Alethopteris*, have by curved dichotomous veins a relation to *Neuropteris*, as they have it at the same time to *Odontopteris* and to *Alethopteris* by the attachment of the pinnules by the whole base and by the connection of the basilar veins to the rachis. I refer to *Alethopteris* the species only with lateral veins nearly in right angle, at least toward the base, merely forking or simple, though distinctly related they may be, by the characters of their fronds, by their shape, and by the position and size of the leaflets to *Callipteridium.*

Prof. Weiss unites into this Genus: *Callipteris Sullivantii*, Lesqx.; *Neuropteris ovata*, Germ.; *N. pteroides*, Goep.; *Odontopteris connata*, Rœm.; *Neuropteris regina*, Rœm., and *Pecopteris gigas*, Gutb. Of these species, *N. ovata* is now placed by Weiss in *Neuropteridium* a section of the *Neuropteris*, proposed by Schimper, which Weiss admits as a new genus; *Odontopteris connata*, Rœm., is referable to *Callipteris* by its nervation; the other species belonging to the Permian or New Red, have the characters of *Callipteridium* as fixed above.

CALLIPTERIDIUM SULLIVANTII, *Lesqx.*

Callipteris Sullivantii, Lesqx., Boston Journ. N. H. S., v. VI, p. 423. Geol. of Penn'a, 1858, p. 866, Pl. V, f. 13. Geol. Rept. of Ill., II, p. 440, Pl. XXXVIII, f. 1.

Alethopteris Sullivantii, Schp., Paleont. Veget., I, p. 561.

Fronds bi or tri-pinnate; pinnæ large, linear-lanceolate; leaflets lingulate, enlarged above the middle, very obtuse, lateral veins close, thin, curved, dichotomous.

Both figures of this species represent simple pinnæ; that of the Rept. of Ill., l. c., is twenty centimeters long, five centimeters broad in the middle, a little narrower at the base and tapering near the top to a small oval terminal pinnule entered up to the middle by the top of the rachis. The lateral pinnules averaging two and a half centimeters, one centimeter broad in the middle, are narrowed to the point of connection near the rachis, where they are joined in narrow obtuse sinuses. The midrib is two millimeters thick at the base, still half as thick at the point where it is dissolved, a little above the middle. The lateral veins numerous, in an acute angle of divergence from the rachis, gradually curve towards the borders, having exactly the neuropterid character.

I have seen of this species the upper part of a compound pinna with three pairs of alternate close secondary pinnæ, the lower one two centimeters long, with short, obtuse or half round broad pinnules or lobes, eight millimeters long and as broad, joined half their length. The medial nerve is distinct in each leaflet, and has with the lateral veins also the same character as in the other fragments described. The second pair of these pinnæ, in ascending, pass to deeply undulate pinnules, about four centimeters long, with the rachis for its midrib, all the lateral veins emerging from it; in the third, the pinnæ are entire, linear-lanceolate obtuse pinnules, not even undulate on the borders. This division is normal, the same as that of the upper part of the pinnæ of the *Alethopterids.* The substance of the leaflets is thick, coriaceous.

Habitat—Lower coal bed of Shamokin, Penn'a, just above the Conglomerate. Roof shale of Colchester and Morris coal; nodules of Mazon Creek, Ill.—Dr. J. H. Britts has sent specimens of it in nodules of Carbonate of Iron, from near Clinton, Mo. Also found at Cannelton, Pa., with the the following.

CALLIPTERIDIUM MANSFIELDI, *Sp. nov., P. XXVII, Figs. 1–2.*

Fronds bipinnate; primary pinnæ lanceolate, the lower part bipinnatifid, simply pinnate at the top; secondary pinnæ mostly large, lanceolate; pinnules connate at the base, oblong, obtuse; midrib comparatively narrow, effaced below the apex; lateral veins oblique curved, dichotomous.

Considering merely the shape of the pinnules of the large pinna f. 1, the species seem closely allied to the former. It is however far different, the leaflets being gradually attenuated to an obtuse point, not enlarged above the middle and not as rounded at the top, curved upwards, rather than backwards, and the pinnæ lanceolate. The substance also is not coriaceous, but rather thin; the primary nerves narrower, not abruptly dissolved; the secondary veins more distinct thicker and not as crowded. The upper part of the pinna f. 2, though of the same general character has its divisions much narrower, and more distant. The lower pinnules at the base of the pinna are attached to the rachis as in *C. Pardeei.* From this, it may be inferred that the rachis may have been partly winged by decurrent leaflets as in the fragment of the last named species, Atl., Pl. XXVI, f. 3.

Habitat—Cannelton; Mr. I. F. Mansfield. Though not very rare, all the specimens obtained until now are small fragments.

CALLIPTERIDIUM NEUROPTEROIDES, *Sp. nov., Pl. XXVII, Figs. 3, 3a.*

Pinnæ large, lanceolate; upper pinnules connate at the base, the lower disjoined, sessile by the whole base, oblong, obtuse; midrib thick, dissolved above the middle; lateral veins thick, at an acute angle of divergence, slightly curved towards the borders, dichotomous.

The substance of this Fern, of which I have seen only the fragment figured, is thick, coriaceous. The upper pinnules joined at the base, are open, the lower ones disconnected, even distant, nearly in right angle to the rachis, sessile by their whole base, the borders being only a little rounded to the point of attachment. The size of the pinnules and apparently of the whole plant is about the same as in the two former species. This is the only point of analogy; for besides their thick coriaceous epidermis, the pinnules of this species have a very distinct nervation, the midrib being merely prominent from the base to the middle where it is effaced, and the lateral veins very oblique scarcely curved and very thick. The upper part of f. 3, enlarged 3*a*, shows the veins thin under the destroyed epidermis.

Habitat—Nodules of Mazon creek, very rare. Among the thousands of specimens which I have seen from the locality, this is the only fragment ever discovered of this species.

CALLIPTERIDIUM OWENII, *Lesqx., Pl. XXXIII, Figs. 6—7.*
Alethopteris Owenii, Lesqx., Geol. Rept. of Arks., II, p. 309, Pl. II, f. 1. Schp. Paleont. veget., I, p. 556.

Frond tripinnate; pinnæ large, in right angle to the broad rachis, distant; pinnules lanceolate, obtuse, rarely acute, connate near the rachis in obtuse sinuses, often decurring; borders undulate; medial nerve distinct to above the middle; veins dichotomous, distant, thin and curved.

The specimen figured represent the different characters of the pinnæ and pinnules of this species. According to their position in the upper or lower part of the fronds, the pinnæ are broader or narrower; the pinnules also, are of various length, and differently joined at the base; but the essential characters are preserved in all. The pinnæ and pinnules are at right angle; the midrib always distinct, sometimes marked to the apex; the veins, oblique at first, more curved in reaching the borders, generally forking twice, are thin, and undulate. The separate leaflet at the right corner of the specimen seems, by its form, especially the acute apex, the thick costa, and the lateral veins merely forked, of a different character, and is, perhaps, referable to another species, though upon the same piece of shale. I found, among a lot of specimens received from Mr. W. Gurley, a large pinna with short obtuse pinnules, comparable by their form to C. Sullivantii, but with the nervation of this species, the veins forking once near the base, and both branches once more near the borders; the midrib flat and broad on the lower surface, but thin and more prolonged on the upper side. The ultimate pinnule is short, triangular, obtuse. I refer the specimen to this species as a variety.

The general facies of this Fern is that of an *Alethopteris*. As all the veins, except the basilar ones, are generally forking twice and curved, its place is with *Callipteridium*. Schimper remarks of this species that it resembles *A. tæniopteroides*, Bunb'y. But this last plant, as far as I know it, has none of the basilar veins attached to the rachis, and is, therefore, a *Pecopteris*, as seen also by its fructifications.

Habitat—Male's coal and Lee's creek coal, subconglomerate, Arks. Mr. Gurley's specimens are labeled Spring creek, Ind.

CALLIPTERIDIUM INÆQUALE, *Sp. nov. Pl. XXXIII, Figs. 2–5.*

Pinnæ large, linear, lanceolate near the apex to a small obtuse terminal leaflet; pinnules irregular in size and position, linear, obtuse, connate near the base, and oblique; or open, more or less distant, subspathulate, rounded to the point of attachment; medial nerve thick, abruptly dissolved below the apex; lateral veins thin, numerous, hidden into the thick epidermis, diverging in acute angle, forking once or twice, and moderately curved.

The pinnules are irregular in size, sometimes shorter in the middle of the pinnæ, and as seen by the fragment f. 5, also very irregular in their position. Their size is equally variable, one to two centimeters long in the middle of the pinnæ, five to seven millimeters broad. The substance of the plant is coriaceous. By this character and the broad middle nerve abruptly dissolved, it is related to *C. Sullivantii* and *C. neuropteroides;* but the midrib ascends higher, the surface of the leaflets is rough, and the veins, though quite as close, are a little stronger and less divided, generally immersed, rarely clear and distinct. The pinnules in the fragment f. 5, narrowed and rounded to the point of attachment, are remarkably like those of a *Neuropteris*.

Habitat—Cannelton, Pa.; found only in fragments.

CALLIPTERIDIUM PARDEEI, *Sp. nov., Pl. XXVI, Fig. 2, 3.*

Frond bi, tripinnatifid; primary pinnæ triangular, rapidly narrowed and deltoid to the apex; secondary divisions alternate or subopposite, open, the lower ones long, linear, lanceolate near the apex, the upper ones simple, undulate, or entire, oblong, obtuse; medial nerve distinct to near the apex; veins in acute angle of divergence, slightly curved, generally twice forked.

In the two fragments, f. 2 and 3, preserved upon the same specimen, on opposite side, the pinnæ are all sessile upon the main rachis, attached to it by the lower pinnules, either distinct, oval; or decurring along it, and triangular obtuse, the rachis becoming then distinctly winged. The lower secondary pinnæ averaging eight to ten centimeters long, are linear, only narrowed near the apex in passing by connate leaflets to very small obtuse terminal ones; their lateral pinnules, six to seven millimeters long, four millimeters broad, slightly oblique, connate above the base, are oblong, very obtuse and entire. The rachis is narrow; the midrib not very thick, is distinct, effaced by divisions below the apex; the veins in very acute angle, thin, very distinct, are more distant than in any of the former species, and also somewhat less curved in passing towards the borders. As in the *Alethopterids*, the upper part of the primary pinnæ is merely pinnate, the simple divisions or pinnules becoming gradually and rapidly shorter toward the top. It is distantly related to *C. Mansfieldi.*

Habitat—I found the specimen, without label, in the museum of the Pardee school of mines, Lafayette College, Easton, Penn'a. From the substance of the stone, it is derived from the Anthracite basin.

CALLIPTERIDIUM RUGOSUM, *Lesqx., Pl. XXXVI, Figs. 1, 2.*

Alethopteris rugosa, Lesqx., Cat. Potts. Ass., p. 11, Pl. I, f. 2. Schp., Paleont. Veget., I, p. 562.

A. obscura, Lesqx., Boston Journ., S. N. H., v. VI, p. 422. Geol. of Penn'a, 1858, p. 865, Pl. I, f. 13–14a.

Frond tripinnatifid; pinnæ oblong rapidly narrowed in the upper part; secondary divisions slightly oblique, alternate, sessile, sub-linear, pinnately, equally and deeply lobed; medial nerve as thin as the veins which are oblique, curved to the borders, distant, forked once or twice.

The first specimens found of this species and described as *Alethopteris obscura*, l. c., had merely fragments of lower pinnæ, like f. 2, with distant lanceolate obtusely acuminate pinnules, more or less regularly pinnately undulate. A better specimen representing the upper part of a pinna, was figured later as *A. rugosa*, l. c., differing from the first by the short connate acute leaflets, with a coarse rugose surface. The large specimen, Atl., f. 1, was discovered still later, with other fragments at the same locality. It evidently represents both forms described under two different names. The primary pinnæ are large; seventeen centimeters long or more, with a round irregularly striate rachis; the lateral branches, four to eight centimeters long, shorter toward the base, and also toward the apex, are regularly deeply lobate in alternate, oblong, obtuse or obovate pinnules, connate to the middle, inclined upwards, the lower ones, on the inferior side, being attached either to the main or to the secondary rachis or between both, cuneate or half round, rather smaller than the others. Those of the upper pairs become confluent to the base of the terminal, lanceolate, obtuse leaflets. The surface of the pinnules being generally wrinkled across, sometimes in the direction of the veins, and always rough, the very thin veins are seen with some difficulty, except the basilar ones which are derived from the rachis. They are attached to a thin flexuous midrib, in a very acute angle of divergence, distant, curving toward the borders, forking once near the base, and generally one of the branches, sometimes both, forking again near the borders. F. 1*b*, copied from that of *A. rugosa*, l. c., and f. 2, are not quite exact. The middle nerve is sometimes decurring but not always and not as much as seen upon the figures, the lower pairs of veins, on both sides, being generally derived from the rachis.

The species is related by its nervation to *Lescuropteris Moorii*, and by the subdivision of its pinnæ to *Pseudopecopteris anceps*. The thin very oblique curved veins, the sessile pinnæ with the lower pinnules sometimes free and attached to the main rachis, refer the plant to *Callipteridium*.

A specimen recently seen in the cabinet of Mr. Lacoe has the primary pinnæ seventeen centimeters long, eight centimeters broad at the base, with both primary and secondary rachis somewhat flexuous in the upper part.

Habitat—Gate and Salem Veins, near Pottsville, upper coal; also found at Oliphant, vein No. 1, and at Wilkesbarre, Oakwood Colliery F?

CALLIPTERIDIUM ALDRICHI, *Sp. nov.*, *Pl. XXXIX*, *Figs. 1–3.*

Frond large, tripinnate; primary divisions lanceolate, slightly broader in the middle, attached in right angle to a broad, regularly narrowly striate rachis; secondary pinnæ linear-lanceolate, in right angle, slightly curved upwards, alternate and sessile, the lower bipinnatifid at the base, simply pinnate in the upper part, entire and merely lobed near the apex under the oblong-obtuse terminal leaflets; medial nerve thick, dissolved and divided above the middle; veins oblique, curved to the borders, forking once; pinnules coriaceous, convex on the upper surface.

I have had for examination a large number of specimens, all from the same locality, but mostly small fragments. The largest one shows part of a primary or perhaps secondary rachis, five to six millimeters thick, with three pinnæ in right angle, one of which, with a fragment of the rachis, is represented f. 1. As it is generally the case in species of *Alethopteris* and *Callipteridium*, the lower pinnæ are pinnately divided, even bipinnatifid towards the base, the pinnules separated even distant; while the middle ones become connate at the base, and gradually more and more connivent, passing at the apex to simple, undulate, long, terminal pinnules. The lower pinnules, in right angle to the rachis, are rounded at the base to the point of attachment, pinnately obtusely lobed; the others are smaller, all entire, linear or oblong, obtuse. The substance of the leaflets is thick, coriaceous, and by this appearance, the species has somewhat the aspect of *Pseudopecopteris nervosa.* But the shape of the pinnules and the venation are very different. All the veins in acute angle of divergence from the midrib curve towards the borders, and are merely forked once; all also are derived from the midrib, except the basilar ones, which, as seen f. 1*a* and 1*b*, come off from the rachis. The shape of the leaflets and their relative position is variable. F. 2 represents a fragment with short, ovate, very obtuse pinnules, all disconnected and distant, the borders irregularly undulately lobed, a mere modification of the form of the lower pinnules of f. 1. F. 3 is a fragment with smaller, separate, oval leaflets, more distant in the upper part, confluent only under the terminal pinnule, and united with it, like those near the apex of the lateral branches of f. 1. This species is comparable to *C. inæquale.* The shape of the leaflets, the thick lateral veins from a narrower midrib, etc., are the more striking differences.

Habitat—Intra conglomerate measures, of Alabama, shale of the Black Creek seam, Jefferson coal mines. Mr. T. H. Aldrich.

CALLIPTERIDIUM MEMBRANACEUM, *Sp. nov., Pl. XXVII, Figs. 4–8.*

Frond polypinnate; secondary divisions linear-lanceolate, either simply pinnate, with the lower pinnules oblong, obtuse, free and undulate, the upper ones gradually shorter, more connate, passing to a short, oblong, obtuse terminal leaflet, or bipinnatifid, with short, linear, deeply pinnately lobed divisions; medial nerve thick, vanishing below the apex; veins oblique, forking once or twice, moderately curved.

The substance of the leaves of this plant is membranaceous; their surface is smooth, and at first sight without any trace of venation. When wetted, however, the epidermis becomes transparent, and the veins quite distinct through its yellowish color. The plant presents, in the characters of its pinnæ and pinnules, the same variety of size, shape and subdivisions as species of *Alethopteris*. The venation is also variable according to the position of the pinnules. In f. 5, the pinnules are entire, connate in the upper part of the pinna, disjointed towards its base, with borders rounded to the point of attachment. The same character is seen in f. 4, whose leaflets are however distinctly and regularly undulate, indicating the separate divisions remarked in f. 6–8. The veins in f. 6, enlarged 6*a*, have the normal character; in f. 7, they merely fork once; in f. 8, they are simple or forked, and the lower ones are distinctly turned upwards, a division dimly marked already upon the upper pinnules of f. 7*a* enlarged. It is thus possible to follow the gradual mutations of forms and of venation. This, without taking into account the peculiar character of the epidermis, would already indicate the reference of all these fragments to a same species. All the pinnules, though their size may be, either connate at the base or free, have the basilar vinelets derived from the rachis. The terminal pinnules are small, round or cuneate to the base. The rachis is apparently large; the fragment f. 4 shows it distinctly striate, either upon the bark or under it.

Habitat—Clinton Coal, Mo. Communicated in numerous specimens by Dr. J. H. Britts.

CALLIPTERIDIUM MASSILIONEUM, *Lesqx.*

Alethopteris Massilionis, Lesqx., Geol. Rept. of Ill., II, p. 438, Pl. XL, f. 1–4.

A. Massilionea, Schp., Paleont. Veget., I, p. 561.

Frond tripinnate; primary rachis thick, irregularly striate; primary pinnæ in right angle, broadly lanceolate; lower secondary pinnæ alternate, open, curved upwards, sessile upon the naked rachis, the upper ones decurring at the base and bordering the rachis by a linear margin; pinnules connate near their base, oblong, lingulate, obtuse, *slightly undulate; midrib thick, dissolved below the apex; secondary veins dichotomous, forking twice, strongly curved, the branches reaching the borders in right angle.*

In this fine species the secondary rachis is winged by the decurring basilar leaflets of the upper pinnæ. The margin is generally linear, but sometimes it enlarges, in the intervals between the pinnæ, into angular pinnules, shorter however and less distinct than those of *C. Pardei*, Atl., Pl. XXVI, f. 3. The secondary pinnæ of various length, according to their position, are nearly linear, or very gradually narrower to the acuminate terminal pinnules one to one and a half centimeters long. The lateral leaflets have the same form as those of *C. Owenii*, but are smaller.

Though the facies of this Fern is that of *Alethopteris* the veins, very curved backwards, dichotomous or forking twice, and the winged rachis, mark its place with *Callipteridium.* Schimper remarks that it is intermediate between *Alethopteris Dournaisii* and *A. Grandini*, both species of Brongniart, from which it differs by the pinnules connate, in an acute angle near the base, as they are in *Al. aquilina.* Its relation seems still more marked with *Neuropteris ovata*, Germ., a species referred to *Pecopteris* by Brongniart, to *Alethopteris* by Goeppert, later placed by Weiss in his genus *Callipteridium* and now in *Neuropteridium* of Schimper.

Habitat—Lower coal of Massillon, Ohio. Not seen elsewhere.

SPECIES INSUFFICIENTLY KNOWN.

CALLIPTERIDIUM INFLATUM, *Lesqx., Pl. XXXIII, Figs. 9, 9a.*

Alethopteris inflata, Lesqx., Geol. Rept. of Ill., IV, p. 393, Pl. X, f. 5–6. Schp., Paleont. Veget., III, p. 500.

Frond pinnately divided; pinnæ linear, narrow; pinnules in right angle, alternate, ovate, broadly obtuse, connate near the base; midrib thick, dissolved at the middle; veins much curved in passing to the borders, once or twice forked; sporanges large, oval, basilar, one only at each side of the costa.

A mere fragment of a pinna remarkable by its short and oval obtuse pinnules, six millimeters long, four millimeters broad, placed in right angle to a narrow rachis, each bearing at the base, on each side of the middle nerve, a large oval or round sporange, one and a half millimeter in diameter. The fructification is marked upon the upper surface of the leaflets by a distinct swelling, wrinkled around, as seen f. 9*a* enlarged. The curved veins inflated, not very distinct, but seen under the glass as in f. 9*a*, relate this fragment to *Callipteridium*, more it seems than to *Alethopteris*. Prof. Schimper remarks that from its peculiar fructification this Fern should represent a group without relation to the pteridoid *Alethopteris*. It seems however to have an analogy to the *Cyatheæ*. *Matonia pectinata*, R. Br., for example, bears at the base of the midrib, and on one side only, a large round sporange which by compression and seen upon the reverse of the leaflets, would have the same appearance as those of this species. There is also an analogy in the nervation, the form, even the disposition of the pinnules, between that living Fern and this fossil species.

Habitat—Nodules of Mazon Creek.

ALETHOPTERIS, *St.* (*Emend.*)

Fronds polypinnate; pinnules coriaceous, simple, mostly entire, enlarged at the base, connate or free, with borders reflexed; midrib distinct, immersed into the epidermis, marked by a groove on the upper surface; prominent on the lower; lateral veins simple or forking once, open, often in right angle to the rachis; fructifications marginal.

Schimper rightly remarks, on this definition, that it is not possible to fix a positive line of demarcation between *Alethopteris* and *Pecopteris*, and that we have to accept the divisions as a mere approximative grouping. The characters which I consider more permanent or distinctive of these genera is the absence of rachial veins in *Pecopteris* the larger size of the pinnules and the disposition of the veins more distinctly in right angle to the costa in *Alethopteris*. As far as known, the fructifications in this last genus are marginal, while in *Pecopteris* they are punctiform, in sori disposed over the lamina in relation to the veins.

ALETHOPTERIS SERLII, *Brgt., Pl. XXIX, Figs. 1–5.*

Pecopteris Serlii, Brgt., Hist. d. veg. foss., p. 292, Pl. LXXXV.

Alethopteris Serlii, Goepp., Syst., p. 301, Pl. XXI, f. 6, 7. Lesqx., Geol. of Penn'a, 1858, p. 865. Schp., Paleont. Veget., 1, p. 555.

Frond at least tripinnate; primary divisions lanceolate; secondary pinnæ pinnately lobed. the upper ones simple; pinnules oblong or lingulate, obtuse or blunt at the apex, confluent at the base; medial nerve thick, deeply sulcate, ascending to the apex; veins in a very open angle of divergence, nearly in right angle to the midrib, very numerous and close, simple or forking once mostly near the middle.

Though the species is common, it is generally represented in fragments of simple pinnæ of the second order, like f. 1, very rarely found attached to the rachis. Of these branches some are very large, with pinnules as long as six centimeters and one and a half centimeter broad. The great difference of size in regard to the position of the pinnules is seen in comparing the figures of our plate. The primary pinnæ and also those of the second order become near the apex, simple alternate pinnules as in the upper part of f. 2, or terminal leaflets as in f. 4, by the gradual connection of the pinnules. From this, the divers modifications of forms seen on the fragments, f. 3, 4, 5, and others, are easily accounted for as resulting from their relation to various parts of the fronds.

This species is very much like the following, easily distinguished however by its broader pinnules, generally enlarged in the middle, more obtuse at the apex, always and distinctly connate at the base and by closer, more numerous veins, generally forking nearer to the middle.

Habitat—Distributed mostly in the lower strata of the middle coal measures. It abounds in the nodules of Mazon Creek, Ill.; in the coal of Clinton, Mo., from which Dr. J. H. Britts procured the large specimen of f. 2, and some of the fragments of the same plate; also at Pittston and

Wilkesbarre, in the Mammoth vein of the Anthracite measures. It is not rare at Cannelton. I have not seen any specimens from the sub-conglomerate coal.

ALETHOPTERIS LONCHITICA, *Schloth.—Pl. XXVIII, Fig. 7.*

Filicites lonchitica, Schloth., Flor. d. Vorw., Pl. XI, f. 22.

Pecopteris lonchitica, Brgt., Hist. d. Veg. foss., p. 275, Pl. LXXXIV and CXXVIII.

P. urophylla, Brgt., ibid., p. 290, Pl. LXXXVI.

P. Davreuxii, Brgt., ibid., p. 279, Pl. LXXXVIII.

Alethopteris Lonchitidis et vulgatior, St., Fl. d. Vorw., I, p. 21, Pl. LIII, f. 2.

A. Sternbergii, Goep., Syst., p. 295.

A. Lonchitidis, Lesqx., Geol. of Penn'a, 1858, p. 864.

A. distans, Lesqx., ibid., p. 865, Pl. XII, f. 2.

A. Lonchitica, Schp., Paleont., Veget., 1, p. 554.

Frond tripinnate, bipinnate in the upper part, simply pinnate near the apex; rachis strong, smooth; pinnæ open, larger in the middle, and bipinnate; secondary divisions linear-oblong, alternate, deeply pinnatifid; pinnules sessile by the whole base, oblique, linear-lanceolate or oblong, obtuse or acute, the lower ones free, the upper connate, gradually more confluent toward the apex, slightly decurring; terminal pinnules long, lanceolate; medial nerve thick, ascending to the apex; lateral veins nearly in right angle, forking once near the base, or simple, thicker. and more distant than in the former species.

This description, abridged from Schimper, gives the characters of the mode of division of the fronds of this and of most of the other species of *Alethopteris*. In this species, the shape, size, and mode of attachment of the leaflets are extremely variable. The pinnules are generally narrow, comparatively longer, lanceolate to the more distinctly acute apex. This, with the difference in the venation, separates it from the former. But the pinnules are so very variable that it is often difficult to decide upon the reference of small specimens, either to this or to the former congener. Besides the normal form, three distinct varieties, perhaps true species, are exposed from American specimens.

1st. Primary pinnæ very long, fragments of one indicating it as nearly seventy centimeters; lower secondary divisions curved upwards from an open angle of divergence, seventeen centimeters long, with comparatively short pinnules, twelve millimeters, linear-lanceolate, obtuse, connate in acute angle near the rachis, and slightly decurring; the terminal pinnule is short, one centimeter, lanceolate, blunt at the apex; the veins are distinct, simple, or forking once from the base; the substance is coriaceous. A number of specimens of this kind come from Canelton, Penn'a.

2d. Tertiary pinnæ long, with a narrow, flexuous rachis; pinnules all free, more or less distant, sessile by the whole scarcely enlarged base, lanceolate, tapering to an acute or acuminate apex, generally curved backwards; veins mostly simple and strong. This form is figured by Brgt., l. c., Pl. XXXVIII; but I do not find it described or even mentioned either by Brongniart or by Schimper. It is *A. Sternbergii* l. c., figured in St., Pl. LIII, f. 2, as *A. vulgatior*, without mention of the character of the nervation.

A fine specimen of this variety, Al. 97, is preserved in the Museum of Comp. Zool., of Cambridge.

3d. Pinnæ of large size, lanceolate; pinnules distant, very narrow, the lower ones scarcely three millimeters broad at the base, three centimeters long, enlarged and decurrent on the lower basilar side, gradually narrowed and sharply acuminate; midrib thin, effaced under the acumen; veins in right angle, thin, scarcely discernible, simple or forking once.

This remarkable variety or species is represented by numerous fragments upon a large slab in the museum of the Pardee school of Easton, Penn'a. The specimen is without label. The pinnæ of this Fern are distantly comparable to Atl., Pl. XXX, f. 4. The branches are, however, twice as long, curved upwards, and gradually acuminate.

A. distans, Lesqx., l. c , is referable to this variety.

Habitat—The species, in its normal characters, is most common in the lower coal of the anthracite basin of Penn'a, the Mammouth, the Five Foot vein; also in the nodules of Mazon creek, and the shale of the Morris coal. I found it also quite abundant in the lower coal of the Kanawha river, above Charlestown. I have not seen it in the specimens from Clinton, Mo.

ALETHOPTERIS GRANDIFOLIA, *Newb'y.*

Geol. Rept. of Ohio, Paleont., I, p. 384, Pl. XLVIII, f. 1, 2.

Frond tripinnate, very large; pinnæ subopposite, the lower ones linear-lanceolate in outline; pinnules either lingulate, enlarged above the middle, round at the apex, or linear-lanceolate, obtusely acuminate, distant and undulate, joined near the base in obtuse sinusses; terminal pinnules narrowly lanceolate; veins figured oblique and dichotomous.

This species is scarcely different from the former, and from the numerous specimens which I have obtained at the same locality, as those described here, as also from a large number of others presented by the author to the museum of Cambridge, I have been unable to find a permanent and distinct specific character. On these specimens, the venation is the same as that of Atl. Pl. XXVIII, f. 7*a*, enlarged, and the pinna, Pi. XLVIII, f. 1, of the Rept. of Ohio, has its segments positively of the same character as in the variety described above, from Cannelton. In this same specimen, the upper pinnæ have the leaflets obtuse, though not distinctly narrowed in the middle, as in f. 2, of this last Rept., and the rachis also is distinctly striate. It seems to be the same form as *A. discrepans*, Daws., Geol. Rept. of Canada, 1871, p. 54, Pl. XVIII, f. 203–205. Considered as a species, it is evidently the ancestor of the former.

Habitat—Abounds at Talmage, over Coal, No. 1, of the Geol. Rept. of Ohio; also in the subcarboniferous measures of Virginia. Prof. W. M. Fontaine.

ALETHOPTERIS HELENÆ, *Lesqx., Pl. XXX, Figs. 1–4.*

A. Helenæ, Lesqx., Geol. Rept. of Ala., 1876, p. 77, (mentioned.)

Fronds tripinnatifid, very large; primary pinnæ linear-lanceolate in outline; secondary divisions in right angle, the upper ones open, all sublinear, gradually shorter and narrower in the upper part of the fronds; pinnules *also in right angle to the rachis, connate and decurrent at the base; medial nerve moderately thick; veins oblique, slightly curved, forking once at the middle, with few intermediate simple veinlets very distinct.*

The rachis is strong, half round, smooth, or minutely striate, with alternate pinnæ in right angle to it. The pinnules average a little more than one centimeter in length in the middle of the largest pinnæ, seven millimeters broad at the decurring base, which generally, as seen, f. 3, joins the inferior pinnules quite near the midrib. Toward the end of the pinnæ, the divisions become gradually shorter and more connivent, and the apex is thus undulate, with a very small obtuse terminal pinnule. The veins sometimes simple, generally fork once near the middle, and rarely one of the branches is divided again in joining the borders. They are more or less oblique to the rachis, and slightly curve in traversing the lamina, generally reaching the border in a slight upward deflection. The characters of this species, far different from those of *A. Lonchitica*, relate it to *A. Grandini*, Brgt., Hist., d. Veg. foss., p. 286, Pl. XCI, f. 1–4. The venation is nearly of the same type, more compact in this species than in the European form, which has also the pinnules comparatively shorter and broader, not decurrent, exactly oblong, broadly obtuse, not narrowed to the apex, altogether a different facies. The delineation of f. 1 and 2 is not perfectly correct; the base of the pinnules is more distinctly decurrent, and generally the basilar border of each inferior pinnule is rounded and cut to near the base of the midrib, where the connection is made, as in f. 3.

Habitat—Roof shale of Helena coal mines, Alabama, sent by Prof. Eug. A. Smith, and more recently by Mr. T. H. Aldrich, from the same locality. Also found at the base of the Chester Limestone, Mercer Co., Ill., by Prof. A. H. Worthen. The cabinet of Prof. Orton, of the Ohio University, has large specimens from the roof shale of the Jackson Coal of Ohio.

ALETHOPTERIS PENNSYLVANICA, *Lesqx.*

Boston Jour., S. N. H., v. VI, p. 423. Geol. of Penn'a, 1858, p. 864, Pl. XI, f. 1, 2. Geol. Rept. of Ill., IV, p. 469. Schp., Paleont. Veget., I, p. 562.

Frond tripinnate; lower pinnæ bipinnatifid in the upper part, with short linear secondary divisions, open, rigid, alternate, cut in short very obtuse leaflets connate to the middle, gradually confluent to near the apex; middle and upper pinnæ of various size, with pinnules in right angle, joined near the rachis, either short, lingulate, obtuse, entire, or longer, linear, obtuse, undulate; midrib distinct to the apex, strong; veins thick, very distinct, simple, or rarely fokring once in the middle.

The species has the same general aspect as the former, from which it differs by the shorter half round divisions of the upper pinnæ, the lingulate leaflets, very obtuse and somewhat narrowed in the middle, their base in right angle, never decurring, and by the nervation, the veins being thicker and more generally simple than forking. Schimper, l. c., compares the species to *A. Grandini*, Brgt., to which it is indeed closely related, differing essentially by the venation, which is less oblique, mostly simple, while in the European species the veins are all forked.

Habitat—Salem vein, near Pottsville. One indifferent fragmentary specimen from the roof shale of the Morris Coal, Ill., is apparently referable to this species. The cabinet of Mr. R. D. Lacoe has specimens from Maltby, Pa.

ALETHOPTERIS AQUILINA, *Schloth.*

Filicites aquilinus, Schloth., Flor. d. Vorw., Pl. V, f. 8; Pl. XIV, f. 21.
Pecopteris aquilina, Brgt., Hist. d. veg. foss., p. 284, Pl. XC.
Alethopteris aquilina, Schp., Paleont. Veget., I, p. 556, Pl. XXX, f. 8–10. Lesqx., Geol. of Penn'a, 1858, p. 864.

Divisions of fronds as in the former species; pinnæ in right angle to the rachis, sublinear, a little broader in the middle, rapidly narrowed near the apex; pinnules in right angle, linear-oblong, slightly enlarging and decurring at the base, connate, or distinct; terminal pinnules small, lanceolate, obtuse; veins slightly oblique, forking twice.

In the American form the pinnules are generally more distinctly narrowed to the obtuse apex, rather lanceolate than oblong. The substance of the leaflets is more coriaceous than in any of the former species and the pinnules are generally flattened on the borders as by marginal fructifications.

Habitat—The best specimens I have seen were communicated by Mr. I. Price Wetherill, of Tremont, Pa., without indication of locality. Specimens bearing the name of this species are found in nearly all the collections; but most of them represent either the following species or *A. Lonchitica*, and therefore though repeatedly quoted as common in the Coal measures, it is as far as I know it, one of the rarest.

ALETHOPTERIS AMBIGUA, *Sp. nov., Pl. XXXI, Figs. 1–4.*

Alethopteris aquilina, Lesqx., Ill. Geol. Rept., II, p. 438.

Fronds tripinnate; rachis thick, with cortex striate; primary divisions dichotomous near the base, large, bipinnate in the lower part, pinnate in the upper; secondary pinnæ open, or in right angle, linear or lanceolate toward the apex; pinnules narrow, linear or lingulate, obtuse, all connate at a distance from the rachis; midrib very thick abruptly dissolved under the apex; veins nearly in right angle, forking once or simple.

From the very thick substance of the leaflets of this Fern always flattened along the borders, and from the shape of the pinnæ and pinnules, most like those of the former species, but smaller, I considered it formerly as the American representative of *A. aquilina*. For the lateral veins are generally immersed into the epidermis and thus appear crowded and much more divided than they are really. But among a large number of specimens from Clinton and Cannelton, I have found some with the venation perfectly distinct, of a character which forcibly indicates this Fern as of a different species. F. 1 shows the base of a pinna with the rachis, eight millimeters broad, striate upon the coaly surface, forking or dichotomous, indicating a fragment of a very large frond. The secondary divisions of alethopterid character are gradually shorter toward the apex, the pinnæ more and more connate toward the top, passing to simple, first undulate and then entire shorter pinnules. The leaflets as seen f. 2 are quite unequal in length, and in f. 1 they are long and regularly undulate on the pinnæ of the right side while on those of the left they are much shorter and entire. Mr. R. D. Lacoe, of Pittston, has in his cabinet very large specimens of this species with the primary pinnæ sixty centimeters long and the secondary branches twenty-five centimeters, whose pinnules two to two and a half centimeters long, are, by size and shape, very similar to those of *A. aquilina.* The venation however is exactly like that of this species.

Habitat—It is as generally distributed in the American coal measures as *A. aquilina* is in those of Europe. It ranges from the base to the upper part of the middle carboniferous series. Abundant at Clinton, Mo.; found at the St. John Coal, Perry Co., Ill.; also at Grape Creek, same State. Common at Cannelton. I have one specimen from Irwin Station, Pa., horizon of the Pittsburg coal.

ALETHOPTERIS GIBSONI, *Sp. nov., Pl. XXVIII, Figs. 4–6, Pl. XXXIII, Fig. 1.*

Fronds large, quadripinnate, very broad; primary divisions large, more than fifty centimeters long; secondary pinnæ linear, tapering in the upper part to an oval obtuse leaflet, oblique, rigid, parallel, distant; tertiary pinnæ open, short, linear, obtuse; pinnules mostly in right angle to the broad rachis, either oblong, obtuse, connate near the base, or half round, joined to the middle, becoming gradually connate in their whole length toward the upper part of the pinnæ, all with borders reflexed; medial nerve thick, abruptly dissolved near the apex; veins nearly at right angle, simple or forked at the base only.

The first specimens, Pl. XXVIII, are from mere fragments received from Illinois. After the engraving of the the plate, I found in the Cabinet of Prof. Ed. Orton, of the Ohio University, many large slabs, representing the species one of the specimens, fifty centimeters square, being covered with primary divisions, none of which however is seen in its whole length. The primary rachis or stipe is eight centimeters broad, flattened, covered with a thick irregularly striate coaly epidermis. The rachis of the primary pinnæ seen at the base of Pl. XXXIII, f. 1, is also broad, fourteen millimeters near its base, still five to seven millimeters in the upper part, where the pinnæ are broken; lower secondary pinnæ oblique, distant, three to four centimeters between their point of attachment, linear, narrowed only in the upper part, where the pinnæ become simply divided by the connection of the pinnules; tertiary divisions in a broad angle of divergence, short, the lower pairs three centimeters long, the others a little shorter, all with a broad flat rachis, two millimeters at base, gradually and slightly narrower to the middle of the half round small terminal pinnule, where it is abruptly effaced, being there still one millimeter. The ultimate divisions or pinnules, alternate, like all the others, are connate to the middle, half round, with reflexed flat borders, as seen Pl. XXVIII, f. *5a* and *5b*. The fragment f. 6 of the same plate, indicates a subdivision of the pinnæ, which is not seen attached to any part of the fronds, though similar separated fragments are seen upon the large specimen of Prof. Orton. The nervation is marked, enlarged, f. *5a* and *6a* and the border f. *5a*, bears, where the reflexed rim is detached, the points of attachment of sporanges, f. *5b*. These, however, are not always perceivable; for in the large specimen, the borders of the leaflets are quite flat, or, when inflated, the reflexed rim does not separate.

The divisions of this Fern are of the same character as those of the genus. But the species differs from all, not merely by the fructification, but by the very large rachis, typically continued by subdivisions to the mid rib of the leaflets. It seems probable, not only from this last character, but from the reflexed border of all the pinnules, without exception, that the specimens merely represent the fructified part of a species whose sterile fronds may have a different character.

Prof. Weiss has, in his Foss. fl., p. 82, Pl. XI, f. 1, under the name of *A. brevis*, a species, which is closely allied to the American plant, and which, indeed, when known from better specimens may be referable to the same. It represents part of a pinna with broad rachis (round and smooth, not flat and striate), bearing linear divisions, with alternate, distant, sessile, linear, obtuse, undulate pinnules, none of which are connate at the base. From the enlarging f. 1*a* and 1*b*, the veins are seen oblique, curved in passing to the borders and all simple. In the American specimens, the pinnules are all connate, and the veins are about in right angle or straight, and half of them, at least, forked at the base. These differences are as far as shown by the specimen of Prof. Weiss, sufficient to authorize a specific distinction, the more so, that the author compares his species to *Pecopteris Miltoni*, Brgt., and *Alethopteris falcata*, Goepp. which both have oblique curved veins, and to which our species bears no relation whatever.

Habitat—Grape Creek, Ill., specimens communicated by Wm. Gibson and Wm. Gurley, Pl. XXVIII. The others, in the cabinet of Prof. Orton, Pl. XXXIII, are from Barnesville, Ohio, roof shale of the coal.

ALETHOPTERIS BUNBURYI, *Andrews*.

Geol. Rept. of Ohio, Paleont., II, p. 421, Pl. LI, f. 3.

Pinnate or bipinnate; rachis slender; pinnules alternate, contiguous, imbricate in the upper part, ovate-lanceolate, rounded to a blunt point; borders more or less undulate; upper leaflets attached to the rachis by the whole base, the lower ones sessile, rounded on the borders to the point of attachment and slightly cordate; medial nerve strong, ascending to the apex; veins rising from the medial nerve in acute angle, then curving towards the borders which they reach straight and in right angle.

The peculiar character of this fragment relates this species to *Neuropteris* by the nervation and the mode of attachment of the lower pinnules; while those of the upper part of the pinna are joined to the rachis by their whole base as in *Alethopteris*. The leaflets are all in right angle to the narrow rachis, the borders distinct to the base, though some of them are contiguous, even imbricate in their whole length. The veins are all from the midrib, dichotomous, once or twice forked, thin, straight to the borders in reaching them. I do not know of any species to which this may be related. The description of the author is very exact, as seen from comparison with the specimens.

Habitat—Base of the coal measures near Rushville, Ohio.

SPECIES INSUFFIENTLY KNOWN.

ALETHOPTERIS FALCATA, *Lesqx.*

Geol. Rept. of Ill., IV, p. 396, Pl. XI, f. 3, 4.

Pinnæ with a broad rachis, simply pinnate; pinnules attached to the rachis by their whole base, disconnected, imbricate on the borders, lanceolate, blunt at the apex, scythe-shaped, very entire; medial nerve strong, veins in right angle, very thin and close, either forking at the base or simple.

The specimen a mere fragment, eight centimeters long, probably represents the circinnate upper part of a pinna of *Alethopteris* in process of unfolding. The rachis, comparatively very thick, five millimeters at the base, rapidly thinning to the apex, bears the crowded pinnules on one side only, and is also slightly hooked, less however than the leaves. These, three and a half centimeters long, smaller in the lower part, appear simple pinnæ, with veins scarcely discernible with a strong glass.

Habitat—Mazon Creek in concretions.

ALETHOPTERIS MARGINATA, (*Brgt.*) *Goepp.*

Pecopteris marginata, Brgt., Hist. d. Veg. Foss., p. 291, Pl. LXXXVII, f. 2.

Alethopteris marginata, Goepp., Syst., p. 301. Lesqx., Geol. of Penn'a, 1858, p. 865. Schp., Paleont. veget., I, p. 559.

Frond bipinnatifid; pinnæ sessile, open, deeply pinnatifid; pinnules contiguous, oblong, slightly obtuse, decurrent, undulate-sinuate; terminal leaflets oblong-lanceolate obtuse; rachis and medial nerve rough, veins very slender, perpendicular to the midrib, nearly simple.

I remarked in the original description, that in the specimen referred to this species, the pinnules are smaller, but that it represents probably the upper part of a frond. The leaflets are scarcely decurrent and distinct to near the base.

The specimen is too small and indistinctly characterized to ascertain its reference to the European species. It may represent only a variety of *A. aquilina*. No other fragments referable to the same species have been found since.

The same uncertainty exists in regard to *A. lævis*, Lesqx., Geol. of Penn'a, 1858, p. 865, a form represented in small fragments whose smooth surfaces do not preserve any trace of nervation.

Habitat—The first is from Tremont New Vein. The second, from Gate Vein, New Philadelphia, Anthracite basin, Pa.

ALETHOPTERIS? MAXIMA, *Andrews*.

Geol. Rept. of Ohio, Paleont., II, p. 421, Pl. L, f. 3, 3b.

Fronds simply pinnate; pinnæ large, linear, entire, rounded and tapering into an obtuse point; medial nerve strong, ascending to the apex; veins once or twice dichotomous, forking generally near the midrib, parallel, curving and in right angle or slightly oblique to the borders, and slightly bending upwards in reaching them.

The fragment described indicates, from the author's remarks, a very large leaf, as it measures seven centimeters in length and twelve millimeters in width. The basilar part is broken. From the size and the shape of the leaf it is comparable to *Danæites* (*Alethopteris*) *Macrophylla*, Newb'y; but the venation is different, the veins being more oblique, apparently more distant, all forking once or twice, curved downward to the midrib and upwards to the border. These characters are those of *Megalopteris*.

The points or dots remarked upon the surface of the leaflets by Prof. Andrews, are regularly placed in rows parallel to the veins. They are the remnants or the base of scales similar to those often seen upon the leaflets of species of *Acrostichum; A. meridense*, Klotz, for example, a species from Venezuela, whose venation is analogous to that of the fossil fragments described above.

Habitat—Near base of the coal measures, Rushville, Ohio, with *Megalopteris*.

PROTOBLECHNUM, *Lesqx.*

Fronds large, simply pinnate; rachis thick, scaly towards the base; pinnæ long, narrow, linear-lanceolate, acuminate, entire, enlarged at base on the lower side to a decurring auricle, generally free; medial nerve percurrent; laterat veins open, curving to the borders, forking twice.

PROTOBLECHNUM HOLDENI, (*Andrews*), *Lesqx.*

Alethopteris Holdeni, Andrews, Geol. Rept. of Ohio, Paleont., II. p. 420, Pl. LI, f. 1, 2.

Specific characters same as described for the genus.

The species, a remarkable one, is represented by two opposite extremities of a frond which, judging from the size of the main rachis, was, in its original state, fifty to sixty centimeters long. The pinnæ are simple, the lower ones shorter, two centimeters long, one centimeter broad near the base, distant; the middle ones six to seven centimeters long of the same width and in the same direction, nearly in right angle to the rachis, are slightly falcate, dilated at the base on the lower side into an obtuse auricle; the upper ones are close, less distinctly scythe shaped, but quite as long, the terminal leaflets being still six centimeters long. The rachis is thick nearly one centimeter at the base, there covered with a thick coating of long scales. The venation as described above is of the *Callipteridium* type and considering this, only, the species might have been described with that genus. But the character of the simply pinnate fronds remove it from the *Alethopterids*, whose fronds, as we know them until now, are always bi or tripinnate.

The relation of this Fern is rather to the *Blechneæ*. *Lomaria attenuata*, Willd., has its pinnæ coriaceous and of the same shape as this fossil plant; and in species of *Blechnum* the similarity is marked not merely by the form of the pinnæ but by the venation. The veins in *Blechnum glandulosum* among others, being curved and forking twice.

Habitat—Same locality as the former, Prof. E. B. Andrews.

PSEUDOPECOPTERIDS.

Primary rachis forking near the base in diverging branches of equal size, or divaricate and dichotomous; branches polypinnate, ultimate divisions sometimes forked; pinnules connate or separated to the base, of various shape, oblong-obtuse or ovate-lanceolate, oblique or in right angle, decurring to the rachis and bordering it by a narrow wing; lateral veins oblique, generally forking once, the lowest pair twice.

Professor Stur in a recent, very important work on the flora of the Culm* (subconglomerate coal measures), has separated under the generic name of *Diplothmema* a group of fossil ferns, whose essential character is marked in the forking of the primary stems in two lateral divisions of equal size, giving to the fronds a semi-lunar shape as seen, Atl., Pl. XXXVII, f. 1. Though this peculiar character is rarely observable on account of the fragmentary state of most of the specimens of fossil Ferns obtainable for examination, the generic division of Stur, *Diplothmema*, contains a number of species evidently related to each other by some common characters which mark them as referable to a peculiar group and which until now have been separately attributed by authors to different genera: *Pecopteris*, *Sphenopteris*, *Asplenites*, *Hymenophyllites*, etc. Their reunion in a separate section is certainly advisable and therefore I admit part of Prof. Stur's division, using however more original or classic names applied to fossil Ferns until now, rather than the Greek name by which the German author represents only the peculiar rarely recognizable forking of the stems.

Though this last character has not been observed upon specimens of all the species referred to this group, it is put in evidence by other points of affinity which fix the mutual relation of the plants. The forking of the branches is seen in the figures of *Pseudopecopteris Mazoniana*, *P. biformis*, *P. Newberryi*, *P. muricata*; especially *P. glandulosa*, *P. decurrens* and *P. speciosa*. It is surmised by the position of the pinnæ in *P. Owenii*, *P. rugosa*, *P. anceps*. Of the last species I have specimens with dichotomous branches.

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*Die Kulm Flora der Ostrauer und Waldenburger Schichten, by Dr. Stur. Vien., 1877.

The most remarkable representative I have seen of this kind of division is from a specimen of *P. nervosa* in the cabinet of Mr. R. D. Lacoe who had the kindness to prepare for a plate some diagrams which have not been figured for want of place. They show the primary rachis, apparently only mere divisions or branches of the fronds, for they are not thick enough for basilar stems, twelve millimeters in diameter, divided into two opposite horizontal branches of the same size, nine millimeters thick, diverging in right angle for a distance of three centimeters on each side, then dichotomous, forking under a divergence of 90°, each branch or pinna about fifty centimeters long, with alternate divisions bearing leaves and variable in length (six to twelve centimeters). From the oblique direction downward of the lower secondary branches, the top of these pinnæ which are generally in right angle, descends towards the base of the primary rachis and cover them. It is exactly the same kind of subdivision observed upon *P. glandulosa*.

As for the other characters ascribed to the genus their evidence in regard to the relation of the species has been remarked in the description of each of them.

PSEUDOPECOPTERIS, *Lesqx.*

§ *Gleichenites.*

Fronds large polypinnate; primary pinnæ very large, pinnate in the lower part, forked near the top; ultimate divisions pinnately lobed as in Pecopteris; venation pinnate.

PSEUDOPECOPTERIS MAZONIANA, *Lesqx.*, *Pl. XXXII, Figs. 1–7a.*

Alethopteris mazoniana, Lesqx., Geol. Rept. of Ill., IV, p. 391, Pl. IX, f. 1–8; Pl. XIII, f. 5, 6. Schp., Paleont. veget., III, p. 499.

Branches pinnately divided in the lower part, dichoto-

mous at the apex; main rachis canaliculate in the middle and striate, flat on the borders; ultimate pinnæ either long, sublinear, gradually tapering to the apex, or short, more distinctly linear, obtuse, pinnately lobed; medial nerve of medium size, gradually thinner upwards, nearly reaching the apex; veins oblique, distant, parallel, forking below the middle.

The general facies of this Fern especially the form and size of the secondary divisions, refer it to *Alethopteris*. The lower ultimate pinnæ, as f. 2, are long, with pinnules separated to the base, even distant, decurring upon the rachis, the basilar ones undulately lobed, indicating a bipinnatifid division of the branches toward their base. The middle pinnæ, like f. 3, have the lobes or pinnules connate at their base, the lower ones indistinctly lobate on the inferior side, all oblong or linear-obtuse, gradually decreasing in length from the base where they measure twelve millimeters in length, to the very small half round terminal leaflets. The largest preserved specimen shows the upper part of a branch, fourteen centimeters long, bipinnately divided in the lower part in open pinnæ, nearly in right angle to the rachis, the lower ones six and a half centimeters long, pinnately regularly lobate; lobes half round, entire, scarcely five millimeters long and half as broad, also in right angle to the rachis, connate at the base, with the venation obsolete. The pinnæ become rapidly shorter the ninth pair from the base being only two and a half centimeters long with short pinnules connate to the middle and above this they are simple and are divided as in f. 5. Excepting the upper leaflets or the pinnæ simple by the confluence of the pinnules, the facies of the Fern as represented by the specimen is that of a *Pecopteris*. Very like to the fragment in Atl., f. 3, Pl. XLIII, merely differing by close rigid ultimate pinnæ and shorter pinnules.

The nervation of this species is exactly the same in all the parts of the plant; the lateral veins are all on the same angle of divergence about 50° and consequently parallel, forking once from below the middle, the lower pairs of the large pinnules only have sometimes one of the branches forking again near the borders. As the veins are all derived from the midrib they leave at the base of each pinnule, by their divergence, an empty space, which, when the pinnules are distant, is prolonged into a narrow wing along the rachis, which is canaliculate in the middle, and flat on the borders. This gives to the species a peculiar appearance and render it easily recognizable, though different in shape and size may be the fragments which represent it.

The fructifications are seen f. 7, in longitudinal simple rows of large round sori, nearer to the borders than to the midrib. On the specimen figured, the sori covered as they are by the epidermis, appear semi-globular or merely convex; but upon other specimens better preserved than those I had at my disposal in Illinois, the epidermis is detached and the sori are seen formed of three or four oblong sporanges, placed starlike around a central point, disposed, as far as can be seen, upon the upper branches of the veins. The substance of this Fern is coriaceous, the upper surface generally convex, furrowed by the impressions of the veins; the borders reflexed.

The pinna f. 1 has some characters different from those described. Though distinctly observed upon the specimen, they do not seem weighty enough to authorize its reference to a different species. The pinnules are abnormally connivent, or some of them either geminate at the base or deeply cut in one lobe at the upper side; the lateral veins are at a slightly more acute angle of divergence; the pinnules more distinctly oval and acute. Nevertheless, all the essential characters are the same as described above, the veins forked once; the rachis winged by the decurring base of the leaflets; the thick texture, etc.

The form of the sori, their disposition in marginal rows upon the upper branch of the veins; that of the sporanges and the forked division of the upper part of the fronds, relate this species to the *Gleicheniæ*.

Habitat—Mazon Creek, in concretions, not rare; never found elsewhere until now. Among a large number of specimens of the sterile pinnæ obtained from Mr. S. S. Strong, the Museum of Comp. Zool. of Cambridge has a few good fruiting ones, Al. 132 and 133.

PSEUDOPECOPTERIS SUBCRENULATA, *Sp. nov., Pl. XXXVII, Figs. 7–8.*

Pecopteris crenulata? Brgt., Hist. d. Veg. foss., p. 300, Pl. LXXXVII, f. 1.

Alethopteris crenulata, Lesqx., Geol. Rept. of Ill., II, p. 439, Pl. XXXIX, f. 2–4; IV, p. 392, Pl. XIII, f. 14–15. Schp., Paleont. Veget., III, p. 499.

Neuropteris conferta, Schp., Paleont. Veget., I, p. 467.

Pinnæ linear, gradually narrowed in the upper part, sessile; pinnules open, nearly in right angle, connate at the base, bordering the rachis as in the former species, oblong, or linear-obtuse, crenulate; middle nerve thin; lateral veins slightly curved, simple or forking.

By the shape of the pinnæ, that of the pinnules, their mode of attachment and the forking of the veins, specimens representing the species have about the same appearance as those of the former. The pinnæ are however narrower, enlarged in the middle, the pinnules flat, of a thinner substance; the veins more open at least in the sterile specimens where they are forked and the medial nerve not as thick.

It seems, at first, from the two fragments figured, that they belong to two different species, on account of the veins, forked in f. 7, simple in f. 8. This last figure represents part of a fructified pinna, as seen from the surface obscurely and undulately swelled by the sori which underneath occupy the middle of the space between the midrib and the borders. In pinnæ of a more advanced stage of decomposition, the dots are more distinct or more salient through the epidermis and often the veins are forked between them as in the sterile pinna. The division of the veins is extremely variable in this species and seems due to mechanical action, like a splitting caused by compression in an advanced stage of maceration or perhaps to a peculiar composition of the tissue. In some pinnæ, the veins are either regularly forked, or split in three or more branches or filaments, three of them diverging from the same point, the two lateral opposite, subdivided again in two or three thin threads, quite near the borders. The direction of the vein upwards or downwards is equally variable upon the same specimen. Hence it has not been possible for me to find any reason to separate into two species the forms represented by the numerous fragments which have lately passed under my examination. I considered them at first referable to *Pecopteris crenulata*, Brgt., but following the authority of Prof. Schimper, I have modified the name. He remarks, Paleont. veget., III, p. 500, that Brongniart's species is a doubtful one, and that its identity with the American plant is far from being ascertained. The European specimens are from the upper coal measures, near Saarbruck; ours are from the base of the middle Carboniferous. The difference in the geological horizon is of some weight in considering identity. Among the specimens which I have examined some have exactly the characters indicated by the French author, others greatly differ, as seen from the above diagnosis, even the borders, distinctly crenate in some specimens, appear nearly entire in others.

A specimen in the Museum of Princeton College, No. 99 of the nodules, represents a large triangular pinna divided as in *P. Mazoniana*. The borders of the pinnules are slightly undulate; the midrib somewhat decurring and more inflated toward the base; the lateral veins are distant four to six pairs, alternate, the lower ones curved inward, forking at the apex, the upper ones straight or slightly curved back, either simple or split at the apex, being as remarked above composed of parallel close filaments either dividing at the top by splitting or preserving the same position and remaining simple to the contiguous borders where some of them are even slighly inflated.

Habitat—Mazon creek, in concretions. Rare.

PSEUDOPECOPTERIS SHEAFERI, *Lesqx., Pl. XXXIII, Figs. 8–8b.*

Pecopteris Sheaferi, Lesqx., Cat. foss., pl., Potts. sci. assoc., p. 11, Pl. 11, f. 4.
Alethopteris Sheaferi, Schp., Paleont. veget., I, p. 562.

Leaf polypinnate; ultimate pinnæ linear-lanceolate, open; pinnules oblique, linear or lingulate, obtuse, connate *and slightly decurring, with borders sinuate; medial nerve thin, gradually effaced toward the apex; veins thin, in an acute angle of divergence, once forked near the base, the upper branch forking again; in the lower pair, both branches are sometimes forked.*

The characters of this species are recognized the same in the specimen figured in the Pots. Cat., l. c., of which the enlarged f. 8*b*, showing the nervation is copied, and in that of Atl., f. 8. They are distinctly seen also upon a fragment, part of a leaf, Al. 19, of the Collection of the Museum of Comp. Zool. of Cambridge, which represents the upper part of a primary pinna with secondary pinnæ open, short, five to six centimeters long; pinnules oblique, unequal in length, averaging one centimeter, gradually shorter towards the end of the pinnæ, with exactly the same nervation as described and figured here. The veins are very thin, in an acute angle of divergence, curving towards the borders. The relation of this species to *Alethopteris aquilina*, indicated by Schp., l. c., is distant and merely marked by the shape of the leaflets. It greatly differs by the thin lateral veins very oblique curved towards the borders, and by the absence of veinlets from the rachis between the base of the medial nerves of the pinnules.

Habitat—Salem vein, near Pottsville, Mr. P. W. Sheafer. The specimen quoted above is from Terris vein, Kentucky.

§ 2. DICKSONIOIDÆ.

Ultimate pinnæ diversely lobate; lobes entire, crenate or dentate, generally decurrent; facies of the Sphenopteris comparable to the present Dicksoniæ.

PSEUDOPECOPTERIS SPINULOSA, *Lesqx., Pl. LVI, Fig. 1.*

Alethopteris spinulosa, Lesqx., Geol. Rept. of Ill., IV, p. 396, Pl. XI, f. 1, 2.

Bi-tripinnatifid; ultimate pinnæ oblique, rigid, alternate; pinnules connate at base, ovate, obtuse; borders sharply denticulate; midrib strong, effaced under the apex; veins oblique, forking once in the middle, divisions entering the teeth.

As seen from the fragment figured, the primary pinnæ are broadly lanceolate, with a strong smooth rachis; secondary pinnæ nearly linear, gradually narrowed to a small oval, dentate pinnule, as seen from another specimen; pinnules sharply toothed, the teeth, the upper ones especially, appearing spinescent. The specimen not figured has the leaflets lanceolate from the middle upwards, more obscurely dentate, the apex, however, sharply acuminate. The medial nerve enlarged toward the base is abruptly dissolved and divided at a distance from the apex, and the lateral veins four or five pairs, alternate, distant, parallel, at an acute angle of divergence, all from the midrib, are forked once only. In both specimens the characters, except the difference indicated above, are the same. The pinnules, ovate, narrowed upwards, and obtuse or pointed, connate to a distance above the rachis, are all about of the same size, less than one centimeter long, five to seven millimeters broad, at their point of cohesion, a little above the rachis. Some of the characters, the shape of the pinnules, their venation, relate the species to the former section. But it has no relation to the *Gleicheniæ*. It is rather allied to the *Dicksoniæ* by the form and position of the leaflets and the nervation, comparable especially to *Dicksonia Plumieri*, Hook.

Habitat—Roof shales of the coal of St. John, Perry Co., Ill. The specimen figured is from the collection of the museum of Comp. Zool. of Cambridge, Al., 116. The second, Al. 102, of the same collection is from Newport, Rhode Island. This specimen is not quite as good. It is disfigured by contraction on one side and expansion on the other from which results the more distinct pointed shape of the leaflets, which on the contracted side are positively obtuse.

PSEUDOPECOPTERIS HYMENOPHYLLOIDES, *Lesqx., Pl. LVI, Figs. 2, 3.*

Alethopteris hymenophylloides, Lesqx., Geol. Rept. of Ill., IV, p. 393, Pl. X, f. 1-4. Schp., Paleont. veget., III, p. 500.

Frond apparently large, tripinnate; divisions lanceolate, sessile and decurring in a narrow wing to the rachis; pinnules oblique, oblong-obtuse, connate at base; borders *sinuate or undulate; medial nerve thin, reaching the apex; lateral veins thin all derived from the midrib at an acute angle of divergence, forking once.*

The different fragments obtained of this fine species indicate the subdivision of the frond. The lower secondary pinnæ at least twelve centimeters long, alternate and oblique, have pinnules two and a half centimeters long, longer still towards the base, eight to ten millimeters broad, gradually shorter towards the apex, all decurrent and joined in acute sinusses near the rachis, very oblique, somewhat curved back from the middle, generally oblong, or lanceolate, obtuse, with undulate or sinuate borders; the rachis is narrow, flat; the midrib very thin, and the veins, five to eight pairs, slightly curved and forking once only at the middle. The upper part of the pinnæ, as seen f. 3, has shorter divisions; the lobes are either deeply undulate lobed, or towards the apex, pass by cohesion to small obtuse entire pinnules. The mode of attachment of the secondary pinnæ to the rachis is marked f. 3. As in most of the species of this group, they are decurring along the rachis bordering it with a narrow wing. The relation of this fine Fern, which, like the former, has no affinity to any species known until now from the coal measures, is also with the *Dicksoniæ;* with *D. barometz*, Link, for example, and still more with *Loxsoma Cunninghami*, Br., which it resembles by the shape and position of the pinnules and nervation.

Habitat—Mazon Creek, in concretions.

PSEUDOPECOPTERIS NERVOSA, *Brgt., Pl. XXXIV, Figs. 1–3.*

Pecopteris nervosa, Brgt., Hist. d. veg. foss., p. 297, Pl. XCIV; XCV, f. 1, 2. Ll. and Hutt., Foss. fl., II, Pl. XCIV.

Alethopteris nervosa, p. 865, Pl. XVIII, f. 3. Geol. Rept. of Ill., II, p. 442. Schp., Paleont. veget., I, p. 513.

Pecopteris Sauveurii, Brgt., ibid., p. 299, Pl. XCV, f. 5.

Fronds tripinnate, or compound dichotomous and multifid; primary pinnæ large, broadly lanceolate; secondary divisions open, linear, lanceolate towards the apex; pinnules oblique, connate from the base or above, ovate-obtuse *or lanceolate, obtusely acuminate, the inferior one, on the lower side, generally bilobate; the terminal ovate-lanceolate, entire or lobate by the confluence of the upper pinnules; medial nerve divided at the apex; lateral veins in an acute angle of divergence, generally forking once.*

The species is locally abundant and easily recognized by the thick substance of its leaflets, with a strong very distinct venation. The midrib is often no thicker than the lateral veins and some of these are casually attached to the rachis, but never passing through the whole of the area between the base of the medial nerves. As seen f. 3, the species is sometimes represented by fragments with equal oblong obtuse pinnules, like those of some *Alethopteris.* The peculiar nervation and the shape of the lower pinnules generally bi-lobed, recall easily the numerous variations to the type. F. 1 is a pinna with unequal alternate pinnæ, those on the left side shorter, with more distinctly acuminate pinnules, and the lower pinnæ on the same side replaced by one geminate leaflet like those remarked upon species of *Neuropteris* and of *Odontopteris.* This is not the only character which relates the plant to *Odontopteris;* for when somewhat effaced by erosion, the basilar veins, of the same thickness as the midrib, appear joined to the rachis, fragments of this Fern resemble those of *Odontopteris Brardii.*

Habitat—Very abundant in the intraconglomerate measures of Alabama, the Helena, the Black veins. Also common in the lower beds of the Anthracite fields, Shamokin, Wilkesbarre. There are large and splendid specimens of the species in the cabinet of Mr. R. D. Lacoe, of Pittston, from the subconglomerate ledge and from Oliphant. The species is rare at Cannelton, still more so in Ill., where I found only a few specimens at Murphysborough low coal; not seen in the specimens from Clinton, Mo.

PSEUDOPECOPTERIS SUBNERVOSA, *Roemer.*

Paleont., IX, p. 192, Pl. XXXI, f. 11. Roehl, Paleont., XVIII, p. 90, Pl. XIII, f. 5 (copied from Roemer).

Frond tripinnate, primary pinnæ lanceolate; secondary divisions open, alternate, sublinear, pinnatified; pinnules *oblique, ovate, acuminate, connate from the middle, the upper ones gradually connivent to near the apex, the inferior larger, entire, not lobate; medial nerve broad and flat; lateral veins flexuous, tending upwards in reaching the borders; forked once, some of the basilar derived from the rachis.*

I have for examination a larger better preserved specimen than the one on which Roemer made his figure and diagnosis. It represents the upper part of two parallel pinnæ, with alternate secondary branches, slightly oblique from a flat rachis grooved or wrinkled crosswise; the pinnules are shorter, broader than in the former species, all very oblique, curving upon each other towards the apex, with a slightly obtuse acumen, none of them bilobate. The venation is peculiar. The midrib flat and scarcely distinguishable from the lateral veins, though broader, is straight towards the apex of the pinnules and effaced by dividing under it; the basilar veins of the inner side (the side toward the main rachis) are derived from the rachis, decurrent at the base, bent upwards from the middle and reaching the borders in an upward direction. Those derived from the midrib are very oblique and also curved upward to the borders, all forking once only. The peculiar character of the venation as also the shape of the lower leaflets, entire at the point of conjunction of the pinnæ to the rachis, separate this species from the former. In my specimen, the veins are much less impressed than in *A. nervosa*, and by the upper pinnules closely joined on the borders, whose apex only is disconnected, and whose medial nerve is scarcely distinct, the plant has exactly the facies of *Odontopteris Brardii.*

Habitat—Communicated from Cannelton Coal by Mr. I. F. Mansfield; one specimen only.

PSEUDOPECOPTERIS PLUCKNETI, *Schloth*, *Pl. XXXIV, Fig. 4; XXXV, Fig. 7.*

Filicites Pluckneti, Schloth., Flor. d. Vorw., Pl. X, f. 9?
Pecopteris Pluckneti, Brgt., Hist. d. veget. foss., p. 335, Pl. CVII, f. 1–3.
Alethopteris Pluckneti, Gein., Verst., p. 30, Pl. XXXIII, f. 4–5. Lesqx., Geol. Rept. of Ill., IV, p. 395, Schp., Paleont. veget., I, p. 511; III, p. 495.

Frond very large, compound, pinnate and dichotomous;

secondary pinnæ large, oblong or ovate-lanceolate in outline, narrower toward the base; tertiary pinnæ, open, linear, with a lanceolate obtuse apex; pinnules oblong, ovate, obtusely acuminate, either larger, disjointed to near the base, with borders undulate, or short, triangular, entire, oblique, connate to above the middle, confluent toward the apex; medial nerve thin or immersed, divided near the apex; lateral veins very oblique once forked.

Our two figures of this species show its essential characters. It would have been impossible however to represent a whole pinna, for, like *P. nervosa*, this species has very large fronds differently composed in their branches either pinnate or dichotomous with pinnæ of large size also. A fragment from Cannelton, twenty centimeters square, is covered with parts of a secondary pinna and the base of another, both obliquely diverging from the top of a primary one, whose rachis is not broader than that of its divisions. The pinnæ and pinnules of this form are represented, Pl. XXXIV, f. 4. The pinnæ are close, nearly in right angle, four and a half centimeters long, all equal in length, with pinnules slightly oblique, disconnected to near the rachis, equally pinnately undulate, or marked each by two or three indistinct lobes on each side. This form exactly agrees with f. 2 of Brgt., l. c. These lateral lobes of the pinnules are generally inflated, at least the lower ones, as by fructification or sori underneath. The surface of the leaflets is covered with a thick epidermis where the immersed veins appear thick as in f. 4*a*, but are really thin when the epidermis is destroyed. The rachis is half cylindrical sinuous, irregularly slightly striate or slightly punctate. In the upper part of the secondary pinnæ, the divisions become rapidly shorter, Pl. XXXV, f. 7, the pinnules entire and triangular. The terminal pinnules at the apex of both the primary and secondary pinnæ are small oval obtuse.

Habitat—Like *P. nervosa*, the fragments of this species are locally very abundant on account of the large size of the plants. It is one of the most common species at Cannelton. The Cabinet of Mr. Lacoe, at Pittston, has specimens from

Wilkesbarre and other localities of the Anthracite. It is not rare at Newport, Rhode Island. It has not been remarked until now below the millstone grit.

PSEUDOPECOPTERIS DIMORPHA, *Sp. nov.*, *Pl. XXXV, Figs. 1–6.*

Frond divided like that of the former; ultimate pinnæ long sublinear; pinnules disjoined to the base, generatty distant, oblong, obtuse, more or tess distinctly undulately lobed, slightly decurrent by the narrowed base, unequal in size on each side of the pinnæ; mediat nerve thick, divided under the apex; venation distinct, of the same character as in the former.

The frond was evidently large, and, as seen f. 4, irregularly divided or dichotomous. The primary rachis as seen in the same figure is large, comparatively to that of the pinnæ which, though very long, have a narrow half round rachis. The pinnules, taken altogether, are much larger than in the former species and generally distant; the lower, on the inferior side of each pinna is more or less distinctly lobed as in *P. nervosa.* The leaflets are also of different size on each side of each pinna, contracted, larger and obtuse on one side, elongated and lanceolate acuminate on the other. As all the specimen are from the Coal of Rhode Island where this peculiar deformation is remarked upon other species, it may be omitted or mentioned as of casual occurrence. But the size, the distance of the pinnules, more distinctly lobate, especially the lower ones, seem to be valid and permanent characters. The fragment, f. 6, is however very like f. 1 of *P. Pluckneti*, in Brgt., l. c.

Habitat—Coal of Mount Hope near Newport, Rhode Island, communicated by Mr. J. H. Clark. Specimens f. 1–5 are in the collection of the museum of Comp. Zool. of Cambridge, Al., 25 and 25b. The others are in the Cabinet of of Amherst College, Mass.

PSEUDOPECOPTERIS NEWBERRYI, *Lesqx., Pl. XXXVII, Fig. 1.*

Sphenopteris Newberryi, Lesqx., Boston Jour. S. N. H., v. VI, p. 420. Geol. of Penn'a, 1858, p. 862, Pl. IX, f 4.

Pecopteris Newberryi, Lesqx., Geol. Rept. of Ill., II, p. 443.

Fronds apparently simple; rachis divided in two diverging pinnæ or dichotomous; primary branches lanceolate; secondary pinnæ alternate, short narrowly lanceolate, sessile, decurrent at base to a narrowly winged, half round rachis; pinnules connate to the middle, inclined outside, ovate obtuse or obtusely acuminate, entire or slightly undulate-crenate.

The specimen figured here is better than the one represented in Geol. of Penn'a, l. c. At least it shows the venation quite distinctly. Other specimens have been obtained from Cannelton, all with the same characters; a simple naked rachis, supporting at the top two branches, divirging crescent shaped, merely differing by the more or less open degree of their divergence. One of these specimens is especially interesting. It repreeents a small pinna which does not seem fully developed; the main rachis is twenty-three millimeters long, four millimeters broad, flattened, nearly smooth, with two pinna diverging in right angles, 90°, each four and a half centimeters long, broadly lanceolate in outline or nearly triangular, the lower secondary pinnæ two centimeters long, the following pairs, fourteen in number, becoming rapidly shorter toward the apex. The pinnules are all of the character represented by the figure; connate to the middle, lanceolate, obtuse or cuneate, obliquely truncate, inclining outside as in some forms of *P. Pluckneti*, only somewhat longer and more or less deeply undulate toward the apex. All the basilar pinnules are entire, none lobed. The venation is also similar to that of *P. Pluckneti*, the veins somewhat more crowded and more numerous, being all derived from the thin midrib, forking once, at or above the middle. Though closely allied to *P. Pluckneti*, the species is always easily recognize by its ramification, and the rachis, convex or half round, flattened on the borders, or narrowly winged by the decurring base of the primary pinnæ. As far at the plant is known until now, it seems to have a simple small frond. The rachis is indistinctly punctate, as in most of the species of this section.

Habitat—The first specimen seen and figured in Geol. of Penn'a l. c., was found by a miner near Summit Lehigh, Pa., and communicated without any other indication. A small specimen has been obtained later from Mazon Creek in nodules; a third from Wilkesbarre is in the collection of the museum of Comp. Zool. of Cambridge; S. S. 7. The others which have more recently come under my examination are from Cannelton, communicated by Mr. I. F. Mansfield. One from Oliphant No. 1 vein, is in the cabinet of Mr. R. D. Lacoe.

PSEUDOPECOPTERIS ABBREVIATA, *Lesqx.*

Sphenopteris abbreviata, Lesqx., Boston Jour. S. N. H., v. VI, p. 419 Geol. of Penn'a, 1858, p. 861, Pl. IX, f. 1, 1b.

Fragment of leaf bipinnate; pinnæ in right angle, alternate, short, flexuous, pinnately, deeply lobed; pinnules joined to the rachis by their whole base, disconnected, slightly decurrent, oblong, narrowed to the obtuse apex, undulate-crenate on the borders; primary nerve thick at its base only, thin and effaced upwards; lateral veins dichotomous, the lower divided in three branches from the middle, the upper ones forked.

This Fern is related to this generic division by the shape of the undulate leaflets, by the rachis flattened on the borders or winged as in *P. Newberryi*, and by the nervation, as in *P. cordata-ovata*. It is intermediate between these two species.

Habitat—Gate vein, near Port Carbon, Pa., the only specimen found.

PSEUDOPECOPTERIS MURICATA, *Brgt., Pl. XXXVII, Fig. 2.*

Pecopteris muricata, Brgt. Hist. d. Veg. foss. p. 352, Pl. XCVII.

P. laciniata, Ll. and Hutt., II, Pl. CXXII.

Alethopteris muricata, Goepp. syst., p. 313. Lesqx., Geol. of Penn'a, 1858, p. 865; Geol. Rept. of Ill., IV, p. 395. Schp., Paleont. veget., I, p. 514.

Fronds very large decompound, dichotomous, or polypin-

nate; secondary pinnæ long, linear-lanceolate; tertiary divisions open, distant, flexuous; pinnules generally distant, very variable in form, lanceolate, acuminate, the lower ones enlarged at the base, more or less distinctly lobed; primary nerve thick, more or less decurrent at base, thinning upwards, dissolved above the middle; veins thick, more inflated towards the borders, the upper forked once, the lower twice; substance coriaceous; rachis smooth or muricate.

It would be difficult to give an idea of all the forms of this species, so variable it is, especially in the shape of the pinnules. The plant was a very large one, some rachis, apparently of pinnæ only, are one and a half to two centimeters broad. Generally the ultimate pinnæ and the pinnules are distant, these attached to the rachis by an enlarged base, decurrent and joined together by a narrow band forming a wing on the rachis. When close to each other, as in the specimen figured, they are connate at base, more distinctly so in the upper part of the pinnæ, where they become oblong, more obtuse, connivent at the base of the small narrowly oval, or lanceolate-acuminate terminal pinnules. They are generally divided in various ways, deeply undulate, sublobate, or enlarged at the base and distinctly lobate on the lower side as in *P. nervosa*, or pinnately lobed from below the apex to the base, the lobes even separated as distinct round pinnules. Generally lanceolate acuminate in the upper part, the lower leaflets are sometimes shorter than the superior ones broadly ovate and regularly trilobate as in *P. trilobata.* The rachis also, though sometimes distinctly punctate or muricate, is often smooth, the largest rachis generally so.

The best figure of this species is that of Roehl, Paleont., XVIII, Pl. XI, f. 1. Ll, and Hutt. have represented the leaflets more divided than they are generally seen. It is however possible that the pinnules of the lower branches of large pinnæ may have this character, so multiplied are their variations.

Habitat—This species is rarely found in large fragments. Some fine and remarkably well preserved specimens have been sent from the Black Vein of the New Castle coal fields of Ala., kindly presented by Mr. Thos. Sharp. A few have been found in the débris of a tunnel crossing a number of coal veins of Sharp Mountain, near Pottsville; later in the concretions of Mazon Creek, and also, more abundantly, in the shale of Newport beach, Rhode Island. I have not seen it in the collections from Clinton, nor in those from Cannelton. It is also not in the cabinet of Mr. Lacoe, of Pittston. The species appear therefore especially limited to the subconglomerate measures of Alabama, passing up to the lower coal of Mazon creek. The geological horizon of the shale of Newport is not positively known.

PSEUDOPECOPTERIS CORDATO-OVATA, (*Weiss*), *Lesqx.*, *Pl. XXXVII, Figs. 4, 5.*

Neuropteris cordato-ovato, Weiss, Foss. fl., p. 28, Pl. I, f. 1.
Pecopteris Sillimanni, Lesqx., Geol. of Penn'a, 1858, p. 867.

Frond bipinnate; rachis comparatively thick; ultimate pinnæ distant, sublinear, gradually narrowed toward the apex, alternate, nearly in right angle; pinnules slightly oblique, close, ovate, rounded and narrowed to the decurring base united by a narrow wing along the slender rachis; medial nerve divided above the middle; veins oblique, slightly curving to the borders, forking once.

The pinnules are uniform in shape and scarcely different in size; the basilar pinnules only are sometimes lobate, on the upper side quite as frequently as on the inferior; but in most of the specimens the leaflets have all the same form, being about exactly ovate, a little more enlarged on the back towards the rachis, and thus very slightly scythe-shaped. They average half to one centimeter in length and four to six millimeters in width in the middle. Comparing this species to *Neuropteris cordato-ovata*, Weiss, l. c., differences are scarcely noticeable. The pinnules are of the same size and form, only none of the basilar ones are lobate in the European specimens, and the veins as described by the author are twice-forked.

From the position of the leaflets, and their mode of attachment to the rachis, the species cannot be placed in the Genus *Neuropteris*. I was formerly disposed to consider this plant as referable to *Pecopteris Loschii*, Brgt., Hist. d. veg. foss., p. 355, Pl. 96, f. 6, which has leaflets of about the same form sometimes lobate, the inferior pinnæ disposed about as in Atl., f. 5, and the veins also simply pinnate. But Brongniart's figure shows the pinnules merely sessile not decurrent and not bordering the rachis, mostly connate at the base, more distinctly lobate, etc. I have never been able to see a Fern of our coal measures satisfactorily representing this species, as described by the French author from specimens from Wilkesbarre.

Habitat—The fragments figured on our plate are also from Wilkesbarre.

PSEUDOPECOPTERIS SILLIMANNI, *Brgt., Pl. XXXVII, Fig. 3.*

Pecopteris Sillimanni, Brgt , Hist. d. veg. foss., p. 353, Pl. XCVI, f. 5. Lesqx. Geol. Rept. of Ill., IV, p. 401. Schp., Paleont. veget., I, p. 515.

Frond tripinnate; pinnæ short, linear-oblong, the lower pinnately deeply lobed, the upper ones simple; pinnules or lobes five to seven pairs, oval, connate at the base, the lower nearly round, sometimes lobed, the terminal ones short, broad, ovate; medial nerves distinct, marked by a deep groove, substance coriaceous, thick; veins undiscernible, very thin, forked once or twice.

The last sentence of the above diagnosis is from Brongniart's description. In our specimen, the only one which seems to distinctly represent the species, the surface is a rough thick epidermis under which the veins are scarcely discernible. As far as can be seen, they appear, however, as figured by the author. Like the former species, this one is very rarely represented in our Coal measures, at least under the same form which was examined by Brongniart from specimens sent to him from Zanesville. It is very probable that both these forms represent different parts of one species only, intimately allied to the following if not identical with it.

Habitat—Subconglomerate ledge of Pittston, Mr. R D. Lacoe; found also in more imperfect specimens in the nodules of Mazon Creek; very rare.

PSEUDOPECOPTERIS ANCEPS, *Lesqx.*, *Pl. XXXVIII, Figs. 1–4.*

Sphenopteris squamosa, Lesqx., Boston Jour. S. N. H., v. VI, p. 420. Geol. of Penn'a, 1858, p. 862, Pl. X, f. 2, 3.

Frond compound, multifid, dichotomous or quadripinnate; primary rachis broad; pinnæ of the third order, oblique, distant, rigid or flexuous; ultimate pinnæ short, inclined upwards, lanceolate or oblong, obtuse, pinnately lobed; pinnules short, round, ovate or subquadrate, connate at the base, the lower generally free, the upper joined to the middle; upper pinnæ simple, undulate, by the gradual cohesion of the lobes; veins forking twice, curving to the borders, all derived from a thin midrib of the same size as the veins.

This species is extremely polymorphous and may represent two or three others described under different names. Very large pinnæ seen in the collection of Mr. R. D. Lacoe are dichotomous in the inferior part; their rachis is large, smooth or narrowly striate, one and a half centimeters broad. The primary pinnæ are broadly lanceolate as also the secondary ones like that figured here. The tertiary, very variable in length and in their divisions are sometimes open or oblique, parallel, rigid; sometimes with a narrow rachis, flexuous, curved in various ways; the ultimate divisions are also extremely variable, more or less distant, two to three centimeters long, lanceolate or gradually narrower to the half round or ovate terminal pinnule; leaflets oblong or broadly ovate, obtuse, even truncate at the apex, the lower ones disconnected at the base, the upper gradually more and more connate. The rachis is slightly punctate. The substance of the leaves is subcoriaceous, the epidermis of the upper surface is thick, generally obscuring the nervation, sometimes but rarely marked by points or small dots, as f. 2; while on the under surface the veins are distinct, f. 1*a*.

In the lower pinnæ of large specimens the pinnules are longer, enlarged at the base, even lobed on each side, or sinuous along the border (Atl., Pl. XXXVIII, f. 2) This form is represented in the Geol. of Penn'a, p. 862, Pl. X, f. 1, as *Sphenopteris Lesquereuxii*, Newby. It may be a different species but the intermediate transition of forms are many and the point of separation indefinite. Some of the numerous specimens of this Fern, compared to the fragment, Atl., Pl. XXXVII, f. 3, referred to *Pecopteris Sillimani*, Brgt., are also in close relation. In this last species, however, the upper surface is quite smooth, the pinnules more distinctly coriaceous, more inflated, and the place of the medial nerve clearly marked through the thick epidermis. This is not the case in *P. anceps*, for indeed though the midrib is obscurely indicated upon the figure, it is generally impossible to see any trace of it, on the upper surface of the leaflets.

F. 3, enlarged f. 4, (Atl.), represents a small fragment found among numerous specimens of this species obtained at Cannelton. The borders are inflated and recurved all around as in the fructified pinnæ of *Alethopteris*. This small fragment is the only one of this character among an immense number of specimens from the same locality. The border is quite flat, the duplication obscure, not even marked around all the pinnules and therefore the character is as yet too indefinite. It is moreover the only trace of fructification remarked in the section of the *Dicksoniæ* of the genus. If more evidence should confirm this character it would prove the close relation of this second section to *Alethopteris* while the fructifications of *P. Mazoniana* must show the affinity of the *Gleicheinites* to *Pecopteris*.

Habitat—First seen in the fragments derived from the tunnel of Sharp Mt., near Pottsville; also at Wilkesbarre and from the Brown Colliery at Pittston. It is in the shale of the Cannelton Coal in great profusion and in the low coal of Illinois; Mazon Creek, Morris and Colchester. I have not seen any specimen of it from the subconglomerate measures nor from coal of Clinton, Mo.

PSEUDOPECOPTERIS DECURRENS, *Lesqx.*

Pecopteris decurrens, Lesqx., Boston Jour. S. N. H., v. 6, p. 424. Geol. of Penn'a, p. 867, Pl. XI, f. 5a.
*Pecopteris alata, Schp., Paleont. veget., I, p. 531.**

Leaf bipinnate, dichotomous or forking in two branches at the apex; rachis flat and broad, irregularly striate; lower pinnæ opposite, linear-lanceolate, open and distant; pinnules distant, oblong, obtuse, entire or slightly undulate, decurring at the base and joined to the inferior ones by a border along the rachis; medial nerve thin, flexuous; lateral veins generally once forked, some of them simple, all curved to the boarders in a broad angle of divergence.

This remarkable Fern is represented only by the fragment figured, the upper part of a pinna or frond, bearing three pairs of lateral opposite pinnæ, the upper ones diverging as branches of a dichotomous rachis, a division similar to that of *P. Mazoniana.* The pinnules, five millimeters long, two to three millimeters broad, with the same distance between them, are decurring and joined to each other by a linear border forming a wing more than one millimeter broad on each side of the rachis. The venation is distinct, but not thick, the midrib thin and flexous, deflected at its point of union to the rachis; the veins forking in the middle rarely simple. The division of the frond at its upper part, the rachis winged by the decurring pinnules, are characters which authorize the reference of the species to *Pseudopecopteris.* It is altogether a peculiar Fern which until now has no distinct relation to any other of the coal measures.

Habitat—Gate vein, near Pottsville; same specimen with *Pecopteris concinna.*

PSEUDOPECOPTERIS CALLOSA, *Lesqx.*

Pecopteris callosa, Lesqx. Geol. Rept. of Ill, II, p. 442, Pl. XXXV, f. 1-5. Schp., Paleont, veget., I, p. 516.

Frond tripinnatifid; pinnæ linear, gradually narrowed in the upper part to a large trilobate deltoid or rhomboidal

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*The name *Pecopteris decurrens* was changed by Schimper into *P. alata*, as preoccupied for a Jurassic species by Andræ, Fl. d. Siebenb., 1863. The Geol. of Penn'a, 1858, indicates precedence for the original name.

leaflet; pinnules oblong or ovate, obtuse, rounded and narrowed at the base, decurrent on the narrowly winged rachis, small and undulate or large and pinnately undulate or lobed, distant; medial nerve broad and flat, abruptly dissolved above the middle; veins all derived from the midrib, forking once below the middle.

This plant has been found only in fragments. The larger one is a part of a bipinnately divided branch, with small distant pinnules, deltoid in outline, obtuse, four to seven millimeters long, undulate and enlarged toward the abruptly contracted and decurring base. Another fragment, a simple pinna, has the pinnules longer, one and a half centimeters, oblong-obtuse, pinnately undulate on the borders, also rounded at the base to a narrow point of attachment half as broad as the inferior part of the lamina. Other fragments show the upper part of the pinnæ with the terminal compound pinnules more or less deeply and irregularly lobate by the cohesion of the upper leaflets.

Schimper rightly remarks on this species, that it resembles *P. Sillimanni*, by the general facies and the size of the pinnæ, which however are more distant. It differs still more by the form of the leaflets, the largest ones always regularly pinnately lobed or undulate, and the small, nearly triangular, enlarged on the sides near the base. The substance of the leaflets is coriaceous, the upper surface polished.

Habitat—I found this species only at Murphysborough and in the shale of the Morris Coal, both localities at the same horizon. The specimens, S. S. 921, are in the Museum of Comp. Zool., Cambridge.

PSEUDOPECOPTERIS GLANDULOSA, *Lesqx.*

Sphenopteris glandulosa, Lesqx., Boston Jour. S. N. H., v. VI, p. 420. Geol. of Penn'a, 1858, p. 862, Pl. IX, f. 2.

Frond dichtomous and tripinnatifid; primary pinnæ in right angle to a broad rachis, or inclined backward; secondary divisions alternate, also in right angle; pinnules distinct to the base, small, ovate in the upper pinnæ, trilobate in the lower, with the terminal lobes lanceolate, *sharply acuminate, the basilar ones half round, all convex, coriaceous, glandular on the surface.*

The specimen figured l. c. is the only one I have seen of this fine species. It represents a primary pinna, with a rachis one centimeter in diameter, dichotomous, divided or forked at the top into two open branches, five millimeters thick, diverging nearly in right angle from the main rachis, which, underneath, is enlarged at the joints of three pair of lateral secondary pinnæ, reflexed or in right angle. The shape of the pinnules is peculiar, the lower, one centimeter long are three or five lobed, the middle lobes tapering to a sharply pointed acumen, while the upper pinnæ have small oval round pinnules two to three millimeters in diameter.

By the shape of the lobate leaflets, this plant is related to *P. acuta*, Atl. Pl. XXXVII, f. 6. The ramification, the form and distribution of the pinnæ and pinnules, the coriaceous substance, refer it to this group. Its affinity to *P. anceps* is also easily recognized.

Habitat—I found the specimen at Shamokin, west of the village. The geological station of the coal bed from which the fragments were thrown out is uncertain.

PSEUDOPECOPTERIS IRREGULARIS, *St., Pl. LII, Figs. 1–3b, 8.*

Sphenopteris irregularis, St., Flor. d. Vorw., II, p. 63, Pl. XVII, f. 4. Gein., Verst., p. 14, Pl. XXIII, f. 2–4. Lesqx., Geol. Rept. of Ill., II, p. 435. Schp., Paleont. veget., I, p. 373.

Sphenopteris latifolia, Ll. & Hutt., II, Pl. CLVI; III, Pl. CLXXVIII.

Sphenopteris trifoliata? Brgt., Hist. d. veg. foss., p. 202, Pl. LIII, f. 3.

Frond polypinnate; rachis comparatively large, alate; secondary pinnæ open, long, narrowly lanceolate; tertiary divisions more oblique, pinnately divided in two to five pairs of reniform or rhomboidal-obtuse, irregular small lobes or pinnules, coriaceous, entire, or the inferior round sublobate; terminal pinnules small, oblong-obtuse; midrib of the same size as the lateral veins, dichotomous; veinlets forking once near the base.

The shape of the leaflets is variable. The American specimens represent them as they are figured in Sternberg, l. c.

In Geinitz, l. c., the lobes are more crowded, generally ovate or obovate, all of the same form, none of them trilobate like those of Atl., f. 2, 3, which, are exactly similar to the figures of *Sphenopteris trifoliata* in Brgt., l. c. I therefore consider these specimens as representing both *S. irregularis*, Stenb., and *S. trifoliata*, Brgt.

The venation of this Fern is obscure on account of the thick epidermis of the leaflets. The surface seems to have been covered by short hairs or villous. When the epidermis is destroyed by maceration, the veins are distinct, inflated, as in f. 3 b.

I had at first considered f. 8 as representing a different species. But after renewed comparison I believe that it merely represents a larger form of the same. The substance of the plant is of the same thickness and the lobes, though larger and less deeply cut, are absolutely of the same form as in f. 2. The essential difference is in the rachis which is stronger and not alate, but f. 8 probably represents inferior divisions. Better specimens are needed, however, to fix the degree of relation of these two fragments. Roemer, Paleont., IV, Pl. XXVIII, f. 5, refers to *P. irregularis*, a part of a pinna with a narrow naked rachis and pinnules trilobate, the lobes, as large as in Atl., f. 8, and also broadly obtuse. The species is extremely variable.

Habitat—The best specimens I have seen are from Clinton, Mo., communicated by Dr. I. H. Britts. The variety f. 5, is from the same place. A few fragments of the species have been found at Colchester, Ill.

PSEUDOPECOPTERIS DENUDATA, *Sp. nov.*

Leaf tripinnatifid; primary pinnæ broadly lanceolate, secondary divisions linear, broader in the middle, close, alternate; rachis flat prolonged and naked beyond the apex; pinnules slightly inclined outside, ovate, sessile, three or five lobed; lobes equal, small, round or oval, free to near the base; veins thin more or less decurring, forked once; substance coriaceous.

Of the two specimens representing this Fern, one is a primary pinna seven centimeters long, with very open secondary divisions, close, slightly curved upwards, four and a half centimeters long; the other a separate secondary pinna with pinnules seven millimeters long in the middle of the pinna, only five millimeters at the base, and gradually shorter toward the apex, the two upper ones very small, confluent with the terminal small half round leaflet. The essential character of this Fern distinctly separating it from all the others of this group is the subdivision of the pinnules in equal oval or round entire small lobes, five in the lower pinnules, three in upper ones, all of the same form and size, disconnected to near the base, averaging two millimeters in diameter. The lowest pair is slightly larger, but none of the lobes are either crenate or sublobate. The rachis of the pinnæ is flat and comparatively broad, one and a half millimeters, excurrent, the upper pinnules being merely simple, a pair of round lobes on each side of the rachis, which, naked and linear, is prolonged beyond the upper pair of pinnules in a blunt acumen five millimeters long. This peculiar termination of the pinnæ resembles that of some of the lobes of *Sphenopteris spinosa*, Goep. The epidermis is thick, and the veins distinct only, when it is destroyed. They are derived from the midrib, either parallel and joining it separately or united at the base, all more or less decurring and generally forked once. The primary rachis is obscurely striate, flat, neither winged nor rugose.

By the form of the pinnules, their subdivisions in round lobes, their mode of attachment to the rachis, this species is closely allied to *Sphenopteris pentaphylla*, Roem., Paleont., IV, p. 180, Pl. XXXI, f. 4, and equally so by the same chararters to *S. stipulata*, Gutb., as figured by Roehl, Foss. fl., p. 58, Pl. XVI, f. 6. Roemer's specimen is a mere fragment of the top of a pinna. Roehl's figure shows the base of the lower pinnules prolonged into stipules which give the name to the plant; in both the rachis of the secondary pinnæ is narrow, and bears a terminal pinnule, not a naked prolongation of the rachis. In any case, by the regular form of the round lobes, close together, separated to near the base, in right angle to the midrib, the species is different from *S. stipulata*, Gutb., as described and figured by the author and by Geinitz.

Habitat—Shale of the Cannelton Coal, Mr. I. F. Mansfield.

PSEUDOPECOPTERIS DECIPENS, *Lesqx., Pl. LII, Figs. 9, 9a, 10, 10a.*

Sphenopteris decipiens, Lesqx., Boston Jour. S. N. H., v. VI, p. 420. Geol. of Penn'a, 1858, p. 862, Pl. XVIII, f. 2. Geol. Rept. of Arks., II, p. 312, Pl. V, f. 1. Schp., Paleont. veget., I, p. 401.

S. dilatata, Lesqx., l. c., p. 310, Pl. II, f. s.

Frond tripinnatifid; ultimate pinæ alternate, open, linear, pinnately divided in three to six pairs of obovate, decurrent lobes, connate at or near the base; medial nerve broad; veins distinct and distant, decurring, joined at the base, or parallel and derived from the midrib, twice forked.

This Fern known from too small fragments is coriaceous, at least as seen from specimen f. 9 which may however represent a different species. The rachis is narrowly winged, the lobes half round or obovate, five to six millimeters long and four to five broad near the apex, where they are generally enlarged, inclined to the outside and imbricated from the middle. The veins, coarsely and obscurely marked on the upper surface but distinctly printed upon the mould, are either joined at the base to a decurring vein as in f. 10*a*, or separate, parallel at the base inclined downwards to the point of union to the midrib. As the difference in the length and shape of the pinnæ and their lobes is as marked as that of the venation, the fragments may represent two species or both pertain as branches of diminutive size to *P. Speciosa* described below.

Habitat—The specimen figured in the Geol. of Penn'a, l. c., is from the lower coal under the Conglomerate in the Gap of Shamokin, Penn'a. The two described in the Arks. Rept. are subconglomerate as also the other fragments of f. 8, sent by Prof. Eug. A. Smith, from Helena coal mines, Ala.

PSEUDOPECOPTERIS LATIFOLIA, *Brgt., Pl. LII, Figs. 4, 4a.*

Sphenopteris latifolia, Brgt., Hist. d. veg. foss., p. 205, Pl. LVII, f. 1–4. Lesqx., Geol. of Penn'a, 1858, p. 862; Geol. Rept. of Ill., II, p. 435. Schp., Paleont veget., I, p. 399.

Frond tripinnate, bipinnate toward the apex; secondary pinnæ long, with a thin alate rachis; pinnules alternate, distant, inclined outside, ovate-lanceolate in outline, obtuse, deeply lobed; lobes half round, entire, the lower ones sometimes irregularly dentate; middle nerve flexuous; lateral veins dichotomous, curved, forking once or twice.

The substance of the pinnules is coriaceous, very thick; the borders generally reflexed, the veins prominent, distinct and strong. The divisions of the pinnules are variable; sometimes the lower ones are obtusely bilobate.

Habitat—Rare in our coal measures. Tunnel of Sharp Mountain, near Pottsville; seen only, in reliable specimens, from the Alabama coal mines of Helena.

PSEUDOPECOPTERIS ACUTA, *Brgt., Pl. XXXVII, Fig. 6.*

Sphenopteris acuta, Brgt., Hist. d. veg. foss., p. 207, Pl. LVII, f. 5. Lesqx., Geol. of Penn'a, p. 862. Schp., Paleont. veget., I, p. 400.

Same characters as the former.

This species merely differs from the former by the acuminate terminal pinnule, and the veins forking one or twice, not more. This difference is remarked upon a large number of specimens from the Whetstone beds of Indiana. The likeness of this Fern to both the former species is so great, that it is difficult to consider it otherwise than as a variety. Though most of the pinnules are simple the lower are sometimes obtusely lobed as in Brgt. figures l. c. of *P. latifolia.* This subdivision is seen upon the right side of the pinna, Atl., f. 6.

Habitat—The identity of habitat of both this and *P. latifolia*, renders their specific separation more objectionable. Both are subconglomerate. Most of the specimens are from the Whetstone quarries of Indiana a formation overlaying the Chester limestone (subconglomerate). The fine small specimen figured is from Dr. Britts upon a piece of hard sandstone, locality not marked. It seems to be derived from the same formation.

PSEUDOPECOPTERIS SPECIOSA, *Sp. nov., Pl. LI, Fig. 1.*

Frond dichotomous, or divaricate-polypinnate; pinnæ very large, with a strong, half round, broadly alate, flexuous rachis; ultimate pinnæ open, lanceolate; pinnules distant, oblique, ovate or ovate-lanceolate, obtusely acuminate, the lower ones three to five lobate, the upper entire by the gradual cohesion of the lobes; medial nerve thick; primary and secondary veins decurring, curved toward the borders, once or twice forked.

From the forking of the rachis on the left side of the figure, this fine species is evidently dichotomous or divaricate-pinnate like *P. nervosa*, to which it has an evident relation in the subdivision of the pinnules, the lower pair in each branch being irregularly lobed with the inferior lobe larger and undulate. In this species both the lower pinnules have this abnormal division while in *P. nervosa* it is marked on the inferior only. The rachis is broadly winged in all its divisions, the base of the pinnules is somewhat decurrent. In the lobate pinnules the veins are derived from simple oblique decurring divisions of the broad medial nerve as in f. 1*a*, enlarged, and are forked once only, but in the upper part of the pinnules when entire, as also in the entire pinnules towards the apex, all the veins are derived from the medial nerve, parallel and simple at the base, as f. 1*b*, enlarged, generally forking twice, once near the base and the branches once again near the borders. The substance of this Fern is coriaceous, the veins inflated or distinct. The surface is generally polished. In the counterpart of the specimen when the epidermis is left attached to the stone as a pellicle of coal, the veins are seen upon it, thin but distinct.

The relation of this fine species to *P. latifolia* and *P. acuta*, Brgt., is quite as intimate as it is to *P. nervosa*. From all these species, it essentially differs by the large size of the leaflets.

Habitat—Helena coal mines, Ala. Communicated by Prof. Eug. A. Smith. Specimen No. 12 of the State cabinet originally labeled under the name of *Sphenopteris amœna*, Sp. nov., (1875).

PSEUDOPECOPTERIS VIRGINIANA (*Meek*). *Lesqx.*

Cyclopteris Virginiana, Meek, Bull. Phil. soc. of Washington, Dec., 1875; Appendix, p. XVIII, Pl. I, f. 3, a, b, c.

Frond apparently large, probably tripinnate; primary pinnæ with rather stout, rigid, smooth or slightly striate rachis; secondary pinnæ long, lanceolate, regularly alternating, close, nearly or quite in right angle to the rachis; pinnules more oblique, alternate, the lower ones shorter and broader, abruptly narrowed or subcordate at base, attached to the rachis by an extremely short petiole, more or less distinctly trilobate, the lobes being obtuse and broad, ovate; upper pinnules gradually longer, five lobed or obtusely sublanceolate, more oblique and less abruptly tapering to the base, becoming simple, merely undulate on the margins, even some quite simple near the extremities of the pinnæ; nervation distinct; veins slender, palmately spreading and bifurcating several times.

The above clear description from the author indicates, as it is seen also by the figure, the close affinity of this and the former species. They only differ by the smooth striate naked (not alate) rachis, for even its smaller branches are not margined by the decurring of the pinnules; by the mode of attachment of the shorter broader pinnules which are merely sessile, not jointed to the rachis by a broad decurring base, and by the close rather neuropterid nervation. The author compares this Fern to species of *Triphyllopteris*, Schp.

Habitat—Lowest strata of the Carboniferous of W. Virginia, in close proximity to the Chemung, at Lewis tunnel, Prof. B. F. Meek.

PSEUDOPECOPTERIS TRIFOLIATA (*Brgt.*), *Lesqx.*

Sphenopteris trifoliata, Brgt., Hist. d. veg. foss., p. 202, Pl. LIII, f. 3. Lesqx., Geol. Rept., of Ill., IV, p. 410. Schp., Paleont., veget., I, p. 371.

Fragment of leaf bipinnate; pinnæ in right angle, par-

allel, distant, rigid, sublinear; pinnules distinct, equidistant, triangular in outline, rounded and narrowed to the point of attachment, distinctly and equally trilobate; lobes very obtuse, the middle one larger and broader at the apex; epidermis thick, smooth or punctulate; veins indiscernible, buried into the epidermis.

The specimen from which the species is described represents it as figured and described by Brongniart with this exception only, that all the pinnules are trilobate, while the French author describes the lower ones as five lobed, the upper ones only three lobed. But our specimen is a fragment of the upper part of a primary pinna, where the lateral pinnæ are much shorter and the pinnules, accordingly, divided as they are in the upper part of the plant figured by Brongniart where the pinnules are trilobate only.

Prof. Schimper remarks, l. c., p. 372, that the specimen figured by Brgt. does not appear referable to the species of Artis, though quoted by him as synonym. Like other related congeners, the species is extremely variable and some of the numerous authors who have quoted and described it, represent it like our specimen or like that figured by Brongniart. Its substance is coriaceous, the upper surface of the lobes convex, the borders reflexed, and the veins hidden.

Habitat—Coal measures of Alabama, Helena mines; communicated by Prof. Eug. A. Smith. Mentioned in Geol. Rept. of Alabama, 1875, p. 75.

PSEUDOPECOPTEIS POLYPHYLLA, (*Ll. and Hutt.*), *Lesqx.*

Sphenopteris polyphylla, Ll. and Hutt., Foss. fl., II, Pl. CXLVII. Schp., Paleont. veget., I, p. 375.

Fragment of leaf bipinnate; pinnæ open, sublinear, close, parallel; pinnules alternate, short pedicelled, ovate in outline, the lower ones pinnately lobed, obtuse; primary nerves distinct near the base, effaced upwards; lateral veins in acute angle of divergence, dichotomous or merely forking, thin.

This species resembles *P. trifoliata*, especially in the upper part of the pinnæ, where all the leaflets are trifoliate.

In the lower part however they are pinnately divided in five or more lobes. The substance of the leaves is not as thick; the veins distinct; the pedicel narrower, slightly decurring to the rachis. The more marked difference is in the middle or terminal lobe which is obovate entire, much larger and longer than the lateral ones.

Habitat—Helena veins, Alabama, rare.

PSEUDOPECOPTERIS MACILENTA, (*Ll. and Hutt.*), *Lesqx.*

Sphenoptoris macilenta, Ll. and Hutt., Foss. fl., II, Pl. CLI. Gein., Verst., p. 14, Pl. XXIII, f. 1. Schp., Paleont. veget., I, p. 400.

S. lobata, Gutb., Abdr., p. 44, Pl. V, f. 11, 13–15; Pl. X, f. 1–3.

Leaf tripinnate; rachis thick; primary pinnæ slightly oblique or in right angle, divaricate, distant; secondary pinnæ pinnately divided in alternate decurring leaflets, the lower ones irregularly trilobate, the upper more or less entire by the confluence of the lobes, broadly ovate, obtuse; primary nerves thick, effaced from the middle upwards; lateral veins in acute angle from an obscure secondary midrib, forking or dichotomous and flabellate.

This species has two different forms. The one, described above, represents it as *S. lobata*, Gutb. l. c. The secondary pinnæ are short, two centimeters, divided in four to five pairs of alternate pinnules, nearly all of the same size, five to seven millimeters in diameter, oval in outline, irregularly three to five lobate, the upper pair only entire or connate forming an enlarged, terminal pinnule, more or less deeply lobed at its very obtuse or subtruncate apex. This form is comparable to Atl., Pl. LII, f. 1; with this difference, that the pinnules are larger, the lobes more distinct and irregular, and the veins as distinct as in f. 4*a* of the same plate. The other form is represented by a single ultimate pinnæ nine centimeters long, pinnately divided in nine or ten pairs of leaflets, gradually smaller from the base to the apex; the lower ones broadly ovate, fifteen millimeters in diameter, irregularly bi or trilobate, with lobes round and entire, some nearly quadrate or rhomboidal entire, narrowed to the base and decurring to the rachis; the upper oblanceolate or cuneiform obtuse, becoming near the apex, connate to a terminal small pinnule which is thus also irregularly indistinctly lobate. This form is the same as that described and figured by Ll. and Hutt., l. c. Our specimen shows the upper surface of the leaflets with veins immersed into the epidermis and obsolete.

This species is closely allied by its characters to *P. irregularis* and its multiple varieties. It differs by the larger size of its decurring irregular lobes and its more distinct nervation. The lobes are diversely cut, generally curved down or decurring at the base, often divided at the top or lacerated in one or two divisions. Some of the specimens seem to represent *Sphenopteris adiantoides*, Ll. and Hutt., while others are scarcely distinguishable from *S. latifolia.*

Habitat—The first specimens described were sent from the Black seam of Jefferson coal mines, Ala., by Mr. T. H. Alrich. The second a single one, is from Cannelton, Pa.

PSEUDOPECOPTERIS PUSSILLA, *Lesqx.*

Pecopteris pussilla, Lesqx., Boston Journ. S. N. H., v. VI, p. 424. Geol. of Penn'a, p. 866, Pl. XI, f. 4. Schp., Paleont. veget., I, p. 519.

Frond bipinnate; primary rachis flexuous, with flat borders; secondary pinnæ distant, narrowly linear, pinnately equally lobed; lobes connate to the middle, obtuse; surface villous.

Nothing is known of this Fern but the small fragment figured. It is part of a pinna four centimeters long, with lateral pinnæ oblique, narrow, five millimeters broad, linear, as far as can be seen, the pinnæ being all broken at a distance from the base. The flexuous alate rachis seems to indicate its relation to this group. But the veins obscurely seen through the villous surface appear merely simple, though curved back to the borders. Except for the winged rachis and the villous surface I should have taken this as a variety of *Pecopteris arborescens*, Brgt.

Habitat—Salem vein, near Pottsville, Pa.

PECOPTERIDS.

The group of *Pecopterids* has been much mixed by authors, and though the separation of the genus *Pseudopecopteris* has simplified it already, it is still interspersed with species whose characters are not in evident correlation, or do not fully answer for the definition of a simple genus.

The subdivision of the tribe into groups, has been attempted, based upon the character of the fructifications. As it has been remarked already in the introduction, the fruits of most of the fossil Ferns are unknown, and when they are observable as in a number of species of the *Pecopterids*, their diagnosis even with the assistance of the microscope is always more or less incomplete. The spores, mostly placed on the lower surface of the leaflets, are seen through the epidermis by protuberances which do not distinctly represent the position of the sporanges in relation to the veins, and when the sori are exposed, they are mostly crushed and disfigured, so that their composition and generally, if not always, the indusium, its shape, point of attachment, etc., are indiscernible. And as fructified pinnæ of Ferns are very often separated from the sterile plants, it happens, as it will be seen in some of the following descriptions, that a specific relation of the fertile fragments to the sterile ones is merely presumable. I have, indeed, as often as possible, represented the fructified part of the *Pecopterids* but cannot take them into consideration as characters for a subdivision of the tribe.

One has only to look at the classification of a few species grouped from the apparent characters of the fructifications, to see how unreliable are the diagnosis derived from them. Goeppert, in his Systema, describes as *Aspidites nodosus* and *A. leptorrachis*, two species referred by Schimper to *Pecopteris arborescens*, while another species of the same author, *Asplenites nodosus* is for Weiss a synonym of the same *P. arborescens* described by him under a new generic name, *Cyathocarpus*, with *C. candolleanus*, *C. Miltoni*, *C. unitus*, this last a *Goniopteris* by its nervation, no more a *Cyathocarpus* by the fructification than *Goniopteris emar-*

ginata, *G. longifolia*, etc. In *Pecopteris*, and because the fructifications are unknown, Weiss places *Alethopteris Serlii*, *Pecopteris Bucklandi* and *P. oreopteridia*, the first a true *Alethopteris* by the large size of the fronds and of their divisions, by the nervation, etc., far different from the two last species true *Pecopteris.* A classification of this kind tending to arrange the fossil Fern of the coal into a natural order according to their fructifications, however commendable it may be from a high scientific point of view, is with the limited knowledge we have of the coal plants, mere perplexing to the student.

Schimper in his master work so often quoted, Paleontologie vegetale, has grouped the *Pecopterids* from their apparent relation to living Ferns, and has separated them in the following order:

1st. *Pecopteris* (*Cyatheites*). Ferns comparable to the living *Cyatheæ* by the characters of the fructifications in round sori, placed in rows parallel to the borders. This is the essential group to which the larger number of the species of *Pecopteris* are referable.

2d. *P.* (*aspidioides*). Ferns whose fructification is in round indusiate sori. In this group the author places most of the species described above as *Pseudopecopteris;* among others, *P. nervosa*, *P. subnervosa*, *P. muricata*, *P. Sillimanii*, *P. Loschii*, *P. callosa*, *P. pussilla*, all Ferns whose fructification is unknown and whose relation to *Aspidium* is therefore uncertain.

3d. *P.* (*asplenioides*). Ferns with fructifications in linear sori. None of our American species are named in this section except *P. serrula* which finds a more appropriate place elsewhere.

4th. *P.* (*acrostichides*). Ferns with the sporanges strewn upon the lower surface of the leaflets. Species of this division are Oolitic and Permian.

5th. The last section describes *Pecopterids* of uncertain relation. One of our species only, *P. decurrens*, finds a place in it.

The clear definition of the genus *Pecopteris* given by Brongniart in his tableau des genres is applicable to the whole group of the *Pecopterids.*

PECOPTERIS, *Brgt.*

Fronds bi, tripinnate; pinnæ long, pinnatified; pinnules adhering to the rachis by the whole base, often more or less deeply connate, not decurring; borders generally contiguous or nearly so; secondary veins derived from the medial nerve of the pinnules, simple, bi or tri-furcate.

As a kind of key for helping the difficult determination of the numerous species of *Pecopteris* I have adopted the following somewhat different mode of grouping them from characters generally persistent and more easily recognized.

1st. *Pecopteris* (*Goniopterids*). The essential character of the Ferns of this division, which Schimper admits as a genus, is the upward curve of the lateral veins as seen upon all the figures of Atl. Pl. XL.

2d. *Pecopteris* (*proper*) *or Cyatheids.* To this belong the species answering exactly to the characters of Brongniart's definition of this genus. This group might be subdivided for species with veins simple or once forked; for those whose veins are twice forked, and for those with the veins branching three times. As some species have a different mode of division of the veins, according to the place of the leaflets upon the pinnæ, I have merely approximately followed in the descriptions the order indicated above without mark or name of subdivisions.

3d. *Pecopteris* (*villous*). The Ferns of this division have the surface hairy or villous. This character is permanent and easily discernible.

4th. *Pecopteris* (*crestate*). Species with pinnæ not distinctly divided into obtuse entire lobes or pinnules, but generally cut on the borders in sharp irregular teeth.

And last a group for a few species of uncertain relation which do not find place in the former divisions.

PECOPTERIS. (GONIOPTERIS.)

PECOPTERIS UNITA, *Brgt., Pl. XL, Figs. 1–7.*

Brgt., Hist. d. veg. foss., p. 342, Pl. CXVI, f. 1-5. Lesqx., Geol. of Penn'a 1858, p. 867. Geol. Rept. of Ill., II, p. 442. Schp., Paleont. veget., I, p. 505. Cyatheites unitus, Gein., Verst., p. 25, Pl. XXIX, f. 4, 5.

Frond large, bi or tripinnate; secondary pinnæ in right *angle, oblong, rapidly narrowed to an obtuse apex; rachis of the ultimate pinnæ broad and flat; pinnules connate to below the middte, or to near the apex, oblong or linear, obtuse; midrib thin, reaching to near the apex; veins simple, curving inside in passing up to the borders, parallel; fructifications in round sori, placed upon the veins in single rows, between the medial nerve and the borders.*

Species extremely variable in the form and size of its ultimate pinnæ very rarely found attached to the main rachis. As seen from the figures, these pinnæ are linear, abruptly rounded to a terminal very small half round pinnule, with leaflets more or less deeply connate, often united to the apex. The detached pinna in the middle of f. 1 represents the more marked variety. According to the more or less deep separation of the pinnules, the lateral veins, curving upwards, ascend more or less high up along the borders; sometimes as in the branch of f. 1, all even the lower pair reach the margin, which is then merely undulate.

The species is always and easily recognized by the broad flat rachis of the ultimate pinnæ; indeed all the fragments of rachis of this Fern are extremely broad, comparatively to the size of the branches which they support as seen f. 2. In f. 1 the pinnæ are apparently joined to a rachis, two and a half centimeters broad, at the base of the figure; but the point of connection is not seen and the pinna of the left side appears as if passing over it. But in f. 2, the connection is clear. The rachis of this branch appears puctulate. F. 7*b* shows the disposition of the sporanges as seen with the microscope. This disposition is like that of *Cyatheites* and *Asteroearpus* of authors.

Habitat—Species locally extremely common. The nodules of Mazon Creek have afforded, by a large number of finely preserved specimens, the means of comparing the multiple forms of the pinnæ and the variable disposition of the sori, according to their more or less advanced stage of maturity. The Museum of Cambridge has more than two hundred specimens of this species in these nodules; it has also the fine specimen f. 1 which I found at Muddy Creek in an old mine between Pottsville and Tremont. The species is also represented at Newport, Rhode Island; around Wilkesbarre and Pittson; at Oliphant, No. 1 vein; at the Salem Vein of Pottsville, etc. I have not seen it in the collections from Cannelton, Pa., and from Clinton, Mo., and therefore though present in the whole thickness of the middle coal measures, its geographical distribution is local. No specimen has been received from the subconglomerate measures.

PECOPTERIS EMARGINATA, *Goepp. Pl. XXXIX, Fig. 11.*

Diplazites emarginatus, Gopp., Syst., p. 274, Pl. XVI, f. 1, 2.
Pecopteris longifolia, Germ., Verst., p. 35, Pl. XIII.
Goniopteris emarginata, Schp., Paleont. veget., I, p. 544.
Pecopteris emarginata, Bunb'y, Foss. pl. of Cape Breton, Quart. Geol. Jour., III, p. 82, Pl. VI.
Cyatheites unitus, Gein., Verst., p. 25, Pl. XIX, f. 4, 5.
Alethopteris emarginata, Lesqx., Geol. Rept. of Ill., IV, p. 398.

Frond pinnately divided; ultimate pinnæ linear, rounded to an obtuse acumen, borders regularly undulate; venation as in the former species.

It is very difficult to find positive characters to separate this species from the former. A comparison of the pinna f. 11, with that in the middle of Pl. XL, f. 1, does not show any marked difference between them. The pinna representing *P. emarginata*, is somewhat shorter and broader and the medial nerve slightly narrower. But in the examination of a long series of specimens, differences far more striking than these become blended together by intermediate forms and it is not possible to see a point where a specific separation might be legitimately fixed. As figured by Geoppert and Geinitz, l. c., the sori of the fructified pinnæ of this species are irregularly scattered and apparently cover the whole surface of the laminas. But as Goeppert and Schimper have already remarked it, this scattering is caused by the maturity of the sori, which when open have their sporanges mixed, irregularly strewn and spread by compression and maceration over the surface. Some of my specimens have those scattered sporanges upon one half of the pinnæ while upon the other, the sori are round and in their natural position as in *P. unita*. From this I am inclined to follow Geinitz's opinion and to consider this so-called species as a variety of the former.

Habitat—Mazon creek always with the former.

PECOPTERIS LONGIFOLIA, *Brgt.*

Hist. d. veg. foss., p. 273, Pl. LXXXIII, f. 2.
Goniopteris longifolia, Schp., Paleont. veget., I, p. 544.
Alethopteris longifolia, Lesqx., Geol. Rept. of Ill., IV, p. 469.

Frond pinnately divided; pinnæ linear-lanceolate gradually tapering to the apex; ultimate pinnæ slightly oblique, distant, narrow linear obtusely acuminate, with borders undulate by the entire cohesion of the pinnules; secondary nerves oblique to the rachis, lateral veins curved upwards and ascending all to the margins.

The specimen from which the diagnosis is made is far better than that seen by Brongniart. It is the upper part of a pinna fifteen centimeters long, bearing alternate open secondary pinnæ, the lower ones fructified, four and a half centimeters long eight millimeters broad, the upper sterile, three centimeters long, less than five millimeters broad, gradually shorter to the apex. The sori are distributed as in *P. unita*, in two rows along and on both sides of the midrib, seemingly covering the whole surface, on account of the narrowness of the lamina, with also the same star-like distribution of the sporanges. The lateral veins are much less numerous than in the former species, three pairs only curving up to the borders and reaching them without connection or anastomosing of the lateral branches. The rachis is comparatively broad, half round.

This species is easily separated from both the former by the narrow linear lanceolate pinnæ, comparatively longer, and the less distinct undulations of their borders.

Habitat—Very rarely found. The specimen described, (P. 451,) of the Museum of Comp. Zool. of Cambridge, and another of the same collection (Al. 93), more fragmentary, are from Mazon Creek. In the cabinet of Mr. Lacoe, there is a still smaller fragment, part of an ultimate pinna, with a clear distinct nervation, labeled No. 192, from the subconglomerate ledge near Pittston.

PECOPTERIS LANCEOLATA, *Lesqx., Pl. XXXIX, Figs. 9, 10.*

Alethopteris lanceolata, Lesqx., Geol. Rept. of Ill., IV, p. 398, Pl. XIII, f. 1–3.

Frond pinnately divided; pinnæ lanceolate to the apex; secondary divisions alternate, narrowly lanceolate, entire, blunt or obtuse at the apex, open, slightly scythe shaped; primary nerve half round, of medium size; lateral veins thin, the middle one very oblique, the branches simple, parallel, ascending to the borders.

I have seen only, of this Fern, the two fragments figured here. One is the upper part of a secondary pinna six centimeters long, with five pairs of distant alternate pinnæ, the lower ones five and a half centimeters long, nearly one centimeter broad, rapidly shorter upwards, the upper ones, those of the fifth pair, being only two centimeters long and half a centimeter broad. The characters of this Fern distinctly separate it from those described above. The substance of the pinnæ is thick; the surface smooth, the midrib narrower, half round, narrowly grooved in the middle; the veins inclined outside in a more acute angle of divergence are extremely thin, scarcely seen through the thick epidermis, even, as in f. 10, totally obsolete; the borders are entire or scarcely undulate, rounded to a broad point of attachment to the rachis.

Habitat—The specimens figured are in concretions from Mazon Creek. They belong to the museum of Comp. Zool. of Cambridge, Al. 64 and Al. 74.

PECOPTERIS ARGUTA, *Brgt., Pl. XLI, Figs. 2–3a.*

Brgt., Hist. d. veg. foss., p. 303., Pl. CVIII, f. 3–4. Lesqx., Geol. of Penn'a, 1858, p. 867.

Polypodites elegans, Goepp., Syst., p. 344, Pl. XV, f. 10.

Goniopteris arguta, Schp., Paleont. veg. I, p. 543.

Frond bipinnate; pinnæ open, rigid, very long, close; pinnules equal, contiguous, connate at base, linear, obtuse; medial nerve straight, distinct to the apex; lateral veins simple, parallel, thick, oblique and straight to the borders.

This species is easily recognized by the peculiar disposition of its lateral veins, eight to twelve pairs, all in exactly the same angle of divergence, 40°, thick and sharply marked The pinnæ are very long, (none seen in its whole), linear, the pinnules mostly equal, average one centimeter in length, and only two millimeters in width. The characters, excepting the number of the veins which increases somewhat in the longer leaflets, are not variable. I have represented f. 2*a*, a fertile pinna, which seems to be referable to this species on account of the disposition of its veins. The fructifications in marginal oval sori are placed upon the end of each vein. The relation of the fragment is however uncertain as it has not been found attached to a sterile branch.

Habitat—Formerly found only in the upper coal beds of the Anthracite, the Salem vein, near Pottsville and New Philadelphia. Later, specimens have been obtained from the Morris coal of Ill. From Mazon Creek I have only the fructified specimen uncertainly referable to this species which is rare and has been mostly found in small fragments.

PECOPTERIS ELEGANS, *Germ.*

Germ., Verst., p. 39, Pl. XV.
Goniopteris elegans, Schp., Paleont. veget., 1, p. 542.

Pinnules long, narrow; veins in a more acute angle of divergence, more distant, five to six pairs.

It is very difficult to separate this species from the former, as the shape of the pinnæ and pinnules, their relative disposition and that of the veins are remarkably similar. There are in the Museum of Comp. Zool. of Cambridge two specimens (P 84 and 84*a*) whose characters perfectly agree with the author's description, the veins being slightly more oblique, less numerous, five to six pairs, and the rachis evidently hairy or scaly. But the number of the veins vary in accordance with the size of the leaflets, and it is scarcely advisable to base a specification upon such a variable character. I have, however, not remarked any trace of points or remains of scales upon the rachis of the former species. A fine specimen in the cabinet of Mr. Lacoe has a coarsely hairy rachis, pinnæ eight to twelve centimeters long, some of its pinnules two to three millimeters broad, with five pairs of very oblique simple veins, while others broader have the veins curving inwards and ascending higher to the borders. The specimen bears also fertile pinnæ with the sori placed upon the veins as in *P. unita*, and with the same star like disposition of the sporanges. The rachis of the pinna is however narrow. The specimen explains how Geinitz, Verst., p. 25, may refer *P. elegans* to *P. unita;* for this last species has often a punctulate rachis like that of the specimen of Pittston. I describe this as a species still uncertain if it is legitimate.

Habitat—Salem Vein of Port Carbon upper coal Oliphant No. 1 Vein.

PECOPTERIS ROBUSTA, *Sp. nov.*, *Pl. XXXIX*, *Figs. 7, 8.*

Pinnæ comparatively large, with a broad rachis, lanceolate in the upper part, linear downwards; pinnules coriaceous, open or in right angle, connate at the base, the upper ones only contiguous, all oblong, obtuse; medial nerve thick, veins curving upwards, simple, parallel, ten to fourteen pairs.

This species is quite distinct from all the others of the division by its more coriaceous texture, the broad rachis of the pinnæ and the thick medial nerve of the pinnules, which enlarged at its point of attachment, is gradually narrower but distinct to the apex. The pinnules, eight to fifteen millimeters long, five to eight millimeters broad at the base, where they are joined in an obtuse sinus, are all more or less distant, the upper ones only contiguous. In the largest leaflets, the veins are distinctly curved inwards, in ascending to the borders; the curve is less marked in the smaller ones, though they are never quite straight, as seen f. 8. The cabinet of Mr. R. D. Lacoe has a number of specimens of this species, all presenting the same characters and all also fragmentary. In the largest pinnules one or two of the veins are split in the middle, a division more marked in the following species.

Habitat—Subconglomerate ledge, Pittston, Pa., Mr. R. D. Lacoe.

PECOPTERIS VENULOSA, *Sp. nov., Pl. XLI, Fig. 1, 1a.*

Pinnæ narrow, with a narrow rachis, pinnately lobed; lobes alternate, linear, generally somewhat broader near the obtuse apex, connate at the base only, inclined upwards, even slightly decurrent, contiguous to above the middle; medial nerve thick; veins oblique, curved upwards, mostly split in the middle, six to eight pairs.

The specimen figured is the only one seen. As in the former species, the medial nerve of the lobes is broad at the base, gradually narrower upwards, or as thin as the veins in the upper part of the pinnules. The species is related to the former by the disposition and the inward curve of the veins, but is clearly distinct by its narrow rachis, the thin substance of the pinnules, and the more general splitting of the lateral veins, as seen f. 1*a*.

Remarking upon his new Genus *Cymoglossa*, Paleont. Veget. I, p. 553, Schimper says that it has a close relation to *Goniopteris*, but that the tertiary veins are mostly bifurcated, a character which does not agree with that of the veins of *Goniopteris*. This assertion is true for the species of the type of *G. emarginata*, whose thin veins, all turned upwards, pass up to the borders of the connate pinnules, as are those of *Cymoglossa*. But in variety of *P. unita*, some of the veins are split as they are in this species. The same kind of division has been remarked still more distinctly in *Pseudopecopteris subcrenulata*.

Habitat—Spring Creek, Indiana. Sent by Mr. Wm. Gibson.

PECOPTERIS (CYATHEITES.)

PECOPTERIS ARBORESCENS, *Schloth., Pl. XLI, Figs. 6, 7.*

Filicites arborescens, Schloth., Flor. d. Vorw., Pl. VIII, f. 13, 14.
F. cyatheus, ibid., Pl. VII, f. 11.
Pecopteris Schlotheimii, St., Flor. d. Vorw., I, p. 18.

P. arborescens, *Brgt.*, *Hist. d. veg. foss.*, *p. 310*, *Pl. CII, CIII, f. 2, 3. Lesqx.*, *Geol. of Penn'a*, *1858*, *p. 867. Geol. Rept. of Ill.*, *II*, *p. 442. Schp.*, *Paleont veget.*, *I*, *p. 499.*

P. aspidioides, *Brgt.*, *ibid.*, *p. 311*, *Pl. CXII, f. 2.*

P cyathea, *Brgt.*, *ibid.*, *p. 307*, *Pl. CI, f. 1–4.*

P. lepidorachis, *Brgt.*, *ibid.*, *p. 313*, *Pl. CIII, f. 5.*

Frond tripinnate; primary rachis thick, smooth or tuberculate; secondary rachis strong, minutely punctate, sometimes smooth; primary pinnæ broadly lanceolate, ultimate divisions linear, open, taper-pointed, generally close; pinnules close, in right angle to the rachis, narrowly oblong, obtuse, convex on the surface, and coriaceous; lateral veins strong, simple or forking once; fructification in two parallel rows of sori, one on each side of the midrib; sporanges disposed star-like.

This Fern is represented in numerous forms or varieties which have been often and are still considered by some authors as distinct species. The upper part of the deltoid primary pinnæ generally resemble a beautiful dwarf tree. The tertiary divisions are narrow especially in the upper part of the pinnæ, scarcely half a centimeter broad, and the small pinnules all equal and simple veined. In the lower part of the pinnæ, the divisions of the same kind are longer, flexuous, one and a half centimeters broad, or more, the pinnules distinctly inequal in length, the veins once forked. This form answers to *P cyathea*, Brgt.—*P. aspidioides*, referred by Schimper to this species has the same characters in the form and disposition of the pinnæ and pinnules; but the veins, instead of being merely inclined to the border, are distinctly curved back. Of specimens with this character of nervation, I have seen only those corresponding to *P cyathea*, Brgt., as represented by the author, l. c., Pl. CI, f. 2*a* *P. lepidorachis*, Brgt., is also referred by Schimper to *P. arborescens* as a variety. The form of the pinnules and their disposition correspond to that of *P. cyathea*, the pinnules being however slightly decurrent at the base. The veins are forked once at the base and the upper branch forked again. I have not seen any specimen with this character, the fragments referred to this species from Mazon Creek being fructified and the nervation invisible.

The fructifications of this species are not rare, but the position of the sori in regard to the veins is not discernible; at least I have never been able to see it, and it has not been described by any author. The sori are large and close, therefore cover the whole surface of the pinnules. The sporanges are obovate, attached star-like by five to the central point.

Habitat—Upper carboniferous measures, especially of the Anthracite basin. Abounds in the roof shale of the South Salem vein of Port Carbon, in connection with *Neuropteris Rogersi* and *Pecopteris arguta* and also at the Gate or Tunnel vein near Pottsville, Tremont, and New Philadelphia. I have not seen it in the low coal of Illinois, indeed nowhere west of Ohio; for the only specimen doubtfully referred to this species from the nodules of Mazon Creek is too imperfect for positive identification. It is not rare at Pomeroy, and in the clay beds between Athens and Marietta, Ohio. With *Neuropteris hirsuta*, it marks the horizon of the upper coal of the middle division, the Pomeroy, the Pittsburg beds, and passes upward to the Permian, becoming still more diversified in its characters and also more prevalent.

PECOPTERIS PLATYRACHIS, *Brgt., Pl. XLI, Fig. 5, 5a.*

Brgt., Hist. d. veg. foss., p. 312, Pl. CIII, f. 4, 5.
P. arborescens, Schp., Paleont. veget., I, p. 499.

Leaf tripinnate; primary and secondary rachis flat, distinctly punctate, smooth and shining; upper secondary pinnæ oblique, short, lanceolate; pinnules very close and narrow linear, obtuse contiguous to the apex; veins simple or forking once, curved back.

The essential characters separating the species is the broad flat rachis, which resembles a fistulose flattened stem, with surface very smooth, rather shining, and punctate. It is represented by two specimens from Cannelton. One apparently the upper part of a branch, has short, lanceolate, oblique pinnæ, the lower ones two and a half centimeters long, gradually shorter towards the apex, seven millimeters broad, with close small narrow pinnules, scarcely one millimeter broad, four to five millimeters long. The middle nerve is distinct, but the lateral veins obsolete.

The other may be the lower part of the same pinnæ, the rachis is one centimeter broad, the pinnæ are slightly oblique, linear, gradually acuminate, eight centimeters long, with pinnules in right angle, irregular in length, and veins forking once. The disproportion of the rachis to the size of the secondary pinnæ is remarkable. Besides this the pinnules are narrower, rather flat than convex and the veins totally obsolete in the smaller leaflets. The difference in the geological horizons, from which the specimens are derived, being added to this, I consider the form as specifically distinct from *P. arborescens.*

Habitat—Cannelton, Mr. I. F. Mansfield.

PECOPTERIS NODOSA, (*Goepp.*) *Schp.*

Aspidites nodosus and A. leptorrhachis, Goepp., syst., p. 372 and 373, Pl. XXIII, f. 1, 2.

Pecopteris nodosa, Schp., Paleont. veget., I, p. 500, Pl. XLI, f. 14.

Cyatheites arborescens, Gein., Verst., p. 24.

Frond tripinnate; rachis thick, inflated or bossed at the joints of the divisions; pinnules in right angle, contiguous, small; sori in two rows, numerous, crowded, round-oval.

There is some uncertainty about this species which, as far as I have been able to see it seems to be merely a variety of *P. arborescens.* The only marked character which separates it is the inflation of the primary or secondary rachis corresponding to the base of the divisions. I have never seen any sterile specimens of the plant. The form and size of the ultimate pinnæ and of the pinnules are the same as in *P. arborescens;* the sori are crowded and appear either round and distant or oval even linear in passing from the midrib to the borders. The different appearances are remarked upon the same specimens, even of small size. This form is extremely abundant in the red, shaly clay, at the bottom of the Grotto of flowers near Marietta. It is even the only species which can be obtained there, and though the shale is very brittle and the specimens small they can afford satisfactory points of comparison. By the rachis they represent *Aspidites nodosus*, Goepp. l. c.; by the rachis also and the form of the pinnæ and pinnules they are referable to *Asplenites nodosus*, of the same author; by the characters of the sori, their position, and by those of the pinnæ and pinnules, they may be referable either to *P. arborescens*, Brgt., or to both the species of Goeppert.

Habitat—Grotto of flowers, near Marietta, Ohio, in red clay; also in the tunnel between Athens and Marietta. Upper veins of the Anthracite. Salem and Gate, near Pottsville, Pa.

PECOPTERIS QUADRATIFOLIA, *Sp. nov.*

Tripinnately divided; pinnæ large, oblong or lanceolate in outline; secondary divisions linear, slightly and gradually narrowed to the apex, open, pinnules close, small, disconnected to the base, oblong, truncate at the top, midrib thick; veins scarcely visible through the thick epidermis, simple, oblique; fructifications in round sori, disposed as in the former species.

This Fern, not rare in the lower coal strata, much resembles the small varieties of *P. arborescens*. It is easily identified by the shape of the very small truncate pinnules, two to four millimeters long and half as broad, of a thick epidermis, flattened around the margins. The rachis is not as thick as in *P. arborescens;* the sori are comparatively larger three to four for each row.

There is in the cabinet of Mr. S. S. Strong a specimen with a pinna thirty-one centimeters long, its ultimate pinnæ five or six centimeters long, bearing both fructified and sterile branches. The characters are preserved on its whole. The museum of Princeton College has also fine specimens of the same kind.

Habitat—Shale of the coal of Morris, Ill.; Cannelton, Pa.; also in the Anthracite basin around Pittston.

PECOPTERIS SQUAMOSA, *Lesqx., Pl. XXXIX, Figs. 12–13.*

Geol. Rept. of Ill., IV, p. 400, Pl. XII, f. 1–4; Pl. XIII, f. 10 and 11. Schp., Paleont. veget., III, p. 496.

Frond large, tripinnate; rachis very thick, distinctly squamose; primary pinnæ lanceolate or oblong, gradually but distinctly tapering to the apex; ultimate pinnæ oblique, narrowly lanceolate, with a very broad rachis; pinnules in right angle, narrow, linear, obtuse, unequal, disjointed to near the base but contiguous; medial nerve thick, reaching the apex; veins totally obsolete; fructification in small round sori placed in one row quite near each border.

The species is very distinct though referable to the group of *P. arborescens*. It has been found in fine and large specimens, its characters being fully preserved in all. The main rachis is one and a half centimeters thick covered in its whole length by long linear acuminate scales which nearly one centimeter long, at the base of the primary rachis, are still eight to ten millimeters near the apex of the secondary pinnæ. The scales are straight, flat, flexuous, or, in the upper divisions, crispate or twisted; when detached, they leave the rachis deeply punctate. The lower ultimate pinnæ are short comparatively to the size of the rachis, five centimeters, open, rigid, the upper ones longer, flexuous, generally curving upwards. The ultimate rachis is still very broad, two millimeters at the base and scarcely narrower toward the point. The pinnules are crowded, numerous, narrow, the largest scarcely two millimeters broad, seven millimeters long, with the thick medial nerve ascending to the apex and no visible trace of veins. The sori, small and round, are placed in rows quite near the borders, six to ten on each side, according to the length of the leaflets.

We have from Cannelton where the species is as abundant as at Mazon Creek, some specimens representing the upper primary pinnæ rapidly narrowed and acuminate, the pinnæ becoming simple pinnules towards the apex and the terminal ones small, oblong, obtuse. The lower secondary pinnæ, also lanceolate acuminate have very narrow pinnules, as narrow as one millimeter; the lower pinnately round-lobed or crenulate near the base, entire from the middle upwards, the upper all entire. This is the normal mode of subdivisions of the pinnæ and pinnules in species of *Pecopteris.* In these specimens however the pinnules are so narrow that with the eye they appear merely crenate, the subdivisions being visible only with a strong glass.

Habitat—Mazon creek, Ill., in nodules; Cannelton, Pa.

PECOPTERIS STRONGII, *Lesqx., Pl. XXXIX, Figs. 14–15a.*

Geol. Rept. of Ill., IV, p. 399, Pl. XIII, f. 7–9. Schp., Paleont. veget., III, p. 497.

Frond bipinnate; pinnæ oblong, broader in the middle, gradually lanceolate to the apex; pinnules alternate, in right angle to a narrow rachis, disconnected, even distant in the lower part of the pinnæ, somewhat enlarged and rounded to the point of attachment, narrower in the middle, obtusely acuminate; medial nerve distinct in the sterile branches; veins obsolete; fructifications in rows of large round sori, close to each border.

The relation of this fine species was, when first described, somewhat doubtful, on account of the peculiar disposition and form of the pinnules, which give to the pinna the appearance of a simply divided frond. I have seen, later, large specimens representing primary pinnæ forty to fifty centimeters long, linear-lanceolate, with secondary divisions alternate or opposite, long, the lowest sixteen centimeters or more. These branches, with a thin smooth, flexuous rachis ascending up parallel to the main stem, or reflexed, and curved in various directions, have their pinnules of the same character as those described and figured upon the plate, variable in length from seven to fourteen millimeters or less according to their place. As in the former species the leaflets become slightly, minutely lobate toward the base of the pinnæ, in their transition from pinnules to branches of a second order. In these specimens the rachis more distinctly exposed is smooth, not punctulate, the pinnules have a thick epidermis, but the veins simple or forking once and obliquely inclined to the borders are sometimes discernible. The fructifications have the same disposition upon all the fragments, the medial nerve of the fertile pinnules being always as if erased and the space between the sori flat.

The only relation I find to this fern is *Cyatheites* (*Pecopteris*) *pulcher*, Heer, Fl. foss. Helv., IV, p. 29, Pl. VIII, f. 7. The specimens not figured, on which is remarked above, have the pinnæ alternate or opposite, as in the European plant; the rachis however is not articulate or noduse at the joints of the secondary branches as figured by Heer. But this is apparently a mere casual deformation. It is not mentioned by the author in the description. Heer also describes the pinnules as subpetiolate, but says that he has seen traces of a petiole only in a few or in one pair of them. Except this all the characters are alike.

Habitat—Roof shale of the coal of Morris; nodules of Mazon Creek; not seen elsewhere.

PECOPTERIS SERPILLIFOLIA, *Sp. nov.*, *Pl. XLVI*, *Figs. 1–3d.*

P. flavicans? (Presl.) Lesqx., Geol. Rept. of Ill., IV, p. 404.

Leaves bipinnatifid; pinnæ linear or narrowly lanceolate; lateral divisions linear-lanceolate, obtuse, enlarged at the sessile base; pinnules inclined outside, connate nearly to the half round apex; primary veins oblique, pinnately branching; veinlets alternate, simple, slightly curved inside; fructification in small round sori placed upon each vein, half way between the medial nerve and the borders.

The short lateral pinnæ, nearly in right angle to a narrow rachis flattened on the borders, are two and a half to three and a half centimeters long, about seven millimeters broad, more or less distant, pinnately cut into more or less deep lobes or connate pinnules, entirely confluent towards the apex in passing to an obtuse terminal leaflet. The two lower pairs are longer. All the pinnules have a separate venation, a medial vein oblique to the rachis, pinnately divided in four pairs of veinlets, simple and slightly curving inside as seen f. 1*a* and 2*a*, enlarged. The fructifications are born upon separate pinnæ (f. 3), whose facies is a little modified by a narrower rachis, and shorter more crowded lateral divisions. The sori, small round dots, are placed upon each veinlet at the point where they become effaced, half way between the medial nerve and the borders. As seen f. 3, *b*, *c*, *d*., these dots, seen under enlarging power, appear as cut into five equal half round sporanges, the large side joining the borders. There is not any appearance of indusium; but the anatomical details seen upon the opaque surface are in this case, as in the other enlarged exposition of the sori, somewhat indistinct. This Fern is coriaceous; all its parts distinctly cut and preserved uninjured in nodules of Iron, may be easily studied. I do not find any affinity to it in any of the species described from the coal measures. My hypothetical reference of this Fern to *Sphenopteris flavicans*, Presl., in St. Flor. d. Vorw., II, p. 127, Pl. XXXVIII, f. 1 *a–c*, is not sufficiently authorized.

Habitat—Nodules of Mazon Creek, not rare and often fructified. Answering Prof. Brongniart's request, specimens of this species were sent to him with many others on which to my regret the celebrated author did not give his views.

PECOPTERIS OREOPTERIDIS, *Schloth.—Pl. XLI, Fig. 8.*

Brgt., Hist. d. veg. foss., p. 317, Pl. CIV, f. 1, 2; CV, f. 1–3.

Filicites oreopteridis, Schloth., Fl. d. Vorw., Pl. IV, f. 9.

Cyatheites oreopteridis, Goepp., Syst., p. 323. Gein., Verst., p. 25, Pl. XXVIII, f. 14. Lesqx., Geol. of Penn'a, 1858, p. 866. Geol. Rept. of Ill., II, p. 442.

Pecopteris oreopteridia, Schp., Paleont, Veget., I, p. 502.

Frond tripinnate; rachis smooth; primary and secondary pinnæ linear-lanceolate; pinnules connate at base, contiguous or distinct, ovate or oblong; veins forking once below the middle, curved, reaching the borders nearly in right angle; fructifications in round sori, as in P. arborescens.

The species is extremely variable, especially in the shape and size of the pinnules, which, upon the upper pinnæ and towards the apex of the primary divisions, become much smaller, crowded, contiguous, like those of *P. arborescens.* The difference is then marked merely by the forked veins and the flat surface of the pinnules. The smooth rachis also, which is never punctulate, may direct for the reference of fragments of this kind. The inclination of the veins is often marked upon the same specimen in a different degree, as I have seen it upon a large pinna in the collection of Mr. Lacoe. It has the lateral veins either nearly in right angle to the medial nerve, or more oblique, merely inclined backwards, but reaching the borders nearly in right angle, or still more oblique, to the medial nerve, and passing upwards to the margin in preserving the same degree of divergence.

Habitat—The whole thickness of the middle coal measures, especially in the anthracite basin. Mazon creek, Ill.; Pomroy, Ohio; upper anthracite beds around Pottsville, Wilkesbarre, Pittston, etc.

PECOPTERIS PENNÆFORMIS, *Brgt.—Pl. XLV, Fig. 1–2a.*

Brgt., Hist. d. veg. foss., and P. æqualis, p. 343, 345, Pl. CXVIII, f. 1–4. Lesqx., Geol. of Penn'a, 1858, p. 867. Schp., Paleont., veget. 1, p. 504.

Fronds large, tripinnate; rachis strong, punctulate; secondary pinnæ linear, oblique; ultimate divisions open, close, short and narrow; pinnules small, ovate, narrowly obtuse, the lower connate at base, the upper ones to the middle, becoming confluent in joining the terminal oblong-obtuse leaflets; medial nerve strong; lateral veins distant, simple, or forking once; sori large, round or oval, in two longitudinal rows, five on each side of the midrib.

Like all the species of *Pecopteris*, the disposition, the form and size of the pinnules, are very variable, and it is sometimes difficult to specifically refer to their species, even the different parts of the same frond. The specimen figured represents the middle part of a large pinna. The lowest secondary pinnæ of the fronds are often bipinnately subdivided, and the ultimate divisions, short and linear, are merely crenate or crenate-lobate on the borders. This last form is *P. æqualis*, Brgt., l. c., f. 1, recognized by the author himself as referable to *P. pennæformis*.

This species has, in its character, a great affinity to the following, differing especially by the rough punctate rachis and the more acute pinnules. The fructified part, f. 2, was not observed upon the same specimen, but mixed in many fragments of the same locality, positively referable to the sterile plant by the form of the subdivisions and the substance of the leaflets. The epidermis of the rachis being destroyed, its projecting dots are not distinctly perceivable. In the large rachis of f. 1, the surface epidermis is very rough, while under it the stem is nearly smooth, marked here and there only by indistinct points. In another specimen the sterile pinnæ, upper branches, have the rachis smooth, while fructified fragments, mixed with them, have the rachis punctulate. The points upon the rachis, especially upon that of the secondary pinnæ, are often undiscernible. As this is the essential character which separates this species from the following, I doubt if it is sufficient to authorize a specific distinction; and I am inclined to think with Gutbier, Gaea., of Sachsen, pp. 82, 83, that the two species are made of fragments of the same. Gein. Verst., p. 26, considers *P. æqualis*, Brgt., as probably identical with *Asplenites ophiodermaticus*, Goepp.

Habitat—Clinton, Mo. Communicated in numerous and very fine specimens, by Dr. I. H. Britts, including those of *P. æqualis*, and of the following species. I found, also, a good specimen in the shale of the Mammoth vein of Raush Gap, Lebanon county, Penn'a. The rachis is very minutely punctate.

PECOPTERIS DENTATA, *Brgt.—Pl. XLIV, Fig. 4, 4a.*

Brgt., Hist. d. veg. foss., p. 346, Pl. CXXIII, and CXXIV.

P. plumosa, Brgt., ibid., p., 348, Pl. CXXI and CXXII. Lesqx. Geol. of Penn'a, 1858, p. 867; Geol. Rept. of Ill., II, p. 442.

Pecopteris dentata, Lesqx., Geol. Rept. of Ill., IV, p. 404. Schp. Paleont. veget., I, p. 508.

Frond large, tripinnate; rachis thick, smooth, grooved in the middle; secondary pinnæ long, linear, the lower flexuous or recurved, bipinatifid, the middle ones straight, *simply pinnately lobed; pinnules oblong, obtuse, or lanceolate to an obtuse acumen, connate towards the base; veins simple or forked.*

Besides the shape of the pinnules not enlarged towards the base, and not as distinctly narrowed to the point, with equal, not crenulate borders, as they are often in the former species, this one differs by the longer, flexous, less rigid pinnæ. The veins are generally more deeply marked, sometimes simple; but, as figured by Brgt., l. c., for both *P. plumosa* and *P. dentata*, more generally forking once. Even near the base of the large pinnules, the upper veinlet is forking once again, as represented Atl., l. c., f. 4*a*. This specimen has the rachis perfectly smooth. Among other specimens of the same species, one especially, from Clinton, has a long, flexous pinna, the preserved part fifteen centimeters long, with short pinnæ ten centimeters long, and pinnules oblong obtuse, only three millimeters long, connate at the base, becoming more and more confluent in passing to simple linear-lanceolate pinnules in the upper part, and all simply veined. The veins are oblique, the lower pair slightly curving inward, the upper ones distinctly arched back to the borders. This pinna has all the characters of *P. plumosa*, Brgt., and is attached to a broad flat grooved primary rachis, evidently punctulate. The points are distant and obscurely marked, but no more so than under the bark of the primary rachis of the former species. There is, nevertheless, a marked difference in the appearance of the rachis, which is flat and grooved in the middle in this species, half round and apparently more solid in the former. This difference may result from the degree of maceration in the fragments preserved.

Habitat—Clinton, Mo., with the former. Also sent in many specimens from Mount Hope, Rhode Island, by Mr. James H. Clark. Mazon Creek, in nodules.

PECOPTERIS ACUTA, *Brgt.*

Hist. d. veg. foss., p. 350, Pl. CXIX, f. 3. Schp., Paleont., veget., I. p. 516.

Leaf bipinnatifid; ultimate pinnæ rapidly shorter to-

ward the apex, open, deeply pinnatifid; pinnules oblique, ovate, acute, connate at base; nerves pinnate; veins simple, slightly marked.

The specimen answering to the description of the author is merely the upper part of a pinna, with the divisions very deeply and distinctly impressed upon the stone. The ultimate pinnæ are longer than in *P. pennæformis*, the pinnules triangular, sharply acute, the medial nerve inflated and the veins simple, scarcely distinct. All the parts of the plant are smooth, the primary rachis flexuous, the ultimate deeply narrowly groved.

Habitat—Recently discovered at Cannelton, by Mr. I. F. Mansfield.

PECOPTERIS ASPERA, *Brgt.*

Hist., d. veg. foss., p. 339, Pl. CXX, f. 1-4.

Leaf tripinnate; primary divisions in right angle, linear lanceolate; secondary pinnæ short, paraltel, with alternate, short, entire, oblong, obtuse pinnules, connate at base; middle nerve distinct; pinnately branching, veins forking once or simple.

The primary pinnæ are somewhat distant, three centimeters, their width being a little less. The secondary ones in right angle and parallel, divided (the lower) into six pairs of pinnules, with a broad ovate or half round terminal leaflet, become gradually shorter and more and more confluent towards the apex, the pinnules, however, remaining distinct to the base of small obtuse terminal leaflets, where they measure scarcely one millimeter in length and width. At the base the secondary pinnæ are a little more than one centimeter long, the middle ones somewhat longer, the lobes or pinnules three millimeters in average length, and two millimeters broad. The leaflets are somewhat thick, but not coriaceous. On the upper surface, the middle nerve only is perceivable. On the under side the veins are distinctly though not sharply marked. The rachis, half round and comparatively thick, is punctate or rough, as described by Brongniart.

Habitat—Morris, Ill., shale, above the coal. Specimen S. S., 202, collection of the Museum Comp. Zool. of Cambridge.

PECOPTERIS CANDOLLIANA, *Brgt.*

Hist., d. veg. foss., p. 305, Pl. C, f. 1. Germ., Verst., p. 108, Pl. XXXVIII. Lesqx., Geol. Rept. of Ill., IV, p. 401. Schp., Paleont, veget., I, p. 500. P. affinis, Brgt., ibid., p. 306, Pl. C, f. 2, 3.

Frond large; ultimate pinnæ long, sublinear; pinnules distinct to the base, narrowly linear, obtuse; medial nerve thick, dissolved under the apex; lateral veins forked once or twice.

A rare species in the American coal measures. It is easily known by its long, narrow, nearly linear pinnules, one to one and a half centimeters long, three to four millimeters broad, slightly decurrent, and more enlarged at base, sometimes a little contracted in the middle; disconnected, even distant. The veins are strong, generally forked once from the middle, and the branches of the same thickness, but rarely forking again, a venation very similar to that of *P. dentata*, Atl., Pl. XLIV, f. 4*a*.

Habitat—The specimens referred to this form are mostly from Mount Hope coal, Rhode Island, and these are all more or less deformed by metamorphism. The essential characters are, however, distinctly preserved. One specimen only is from Mazon creek.

PECOPTERIS CISTII, *Brgt.—Pl. XLI, Fig. 4.*

Brgt., Hist. d. veg. foss., p. 330, Pl. CVI, f. 1, 2. Lesqx., Geol. of Penn'a, 1858, p. 866; Geol. Rept. of Ill., II, p. 441. Schp., Paleont. veget., I, p. 510.

Primary pinnæ linear, oblong; secondary divisions linear, slightly oblique, rigid; pinnules broadly ovate, connate at base, contiguous to above the middle, the terminal obovate; medial nerve thick at the base, effacing in dividing above the middle; veins distinct, forked near the base, with one or both branches forking again, curving in passing to the borders.

The species is scarcely known to me. Brongniart described it from one specimen sent by Cist, from Wilkesbarre. and from another from England. Though I have seen many fragments referred to it, I have never been able to positively recognize in any the characters indicated by the author. Our figure is a copy of the upper half of that of Brongniart, l. c.; it shows a comparatively narrow rachis; pinnules broadly ovate, equal in size, five to seven millimeters long, four to five millimeters broad at the connate base, inclined outward, and the veins disposed as in Atl., f. 4*a*. The upper part of the pinnæ of *P. pteroides* and of *P. polymorpha*, often present the same characters. Except Brongniart, none of the European authors have seen a specimen of it. Goeppert, Syst., Unger and Schimper l. c., describe it from Brongniart, recording the localities indicated by the author—Wilkesbarre, and Bath, England—from a specimen in the museum of the University of Oxford. It is from this last specimen that f. 2 of Brgt. is made, and that our figure is copied. F. 1 has the main rachis destroyed, the pinnules longer, the veins apparently indistinct, and it is with this one that agree all the specimens mentioned above. I consider them as rather referable to *P. polymorpha*, or *P. Miltoni*, than to *P. Cistii*.

Habitat—Specimens dubiously referred to the species are from Wilkesbarre, from the Mammoth vein of Raush Gap and from Mazon creek

PECOPTERIS BUCKLANDI, *Brgt.*

Hist. d. veg. foss., p. 319, Pl. XCIX, f. 2. Lesqx., Geol. Rept. of Ill., IV, p. 401. Schp., Paleont. veget., I, p. 504.

Frond tripinnate, ultimate pinnæ slightly oblique; pinnules close, connate at base, oblong, narrowly obtuse; medial nerve thick, lateral veins once forked, the lower pairs twice.

Brongniart places this species in the group of those with a glabrous rachis. All the American specimens which I consider referable to it, show the rachis smooth, even polished, but distantly punctulate or scabrous when observed by the glass. The pinnæ are comparatively broad and short, six to seven centimeters long, fifteen to seventeen millimeters broad in the middle, where the pinnules are generally a little longer; pinnules oblique, close, connate at the base, even to the middle, the lower ones sometimes disconnected, all about of equal width, four millimeters, rapidly shorter towards the apex, where the two or three upper pairs become confluent and united to a small terminal triangular leaflet. The veins, in an acute angle of divergence, reaching the borders with only a slight curve, are generally forked once near their base, and one of the branches forking again, sometimes both.

Pecopteris Bucklandi, *P. oreopteridis*, and *P. Cistii*, are closely allied species, which it is difficult to separate, especially from fragmentary specimens. The first has large, comparatively short ultimate pinnæ, with narrow longer pinnules, lanceolate into a narrowly obtuse acumen, the ultimate leaflet is triangular, acute. The veins are in a more acute angle of divergence about 30°, nearly straight to the borders, the rachis slightly muricate. Both the other species have shorter, comparatively broader, more obtuse pinnules. In *P. oreopteridis*, the veins are curved to the borders, nearly in right angle, forked once only. In *P. Cistii*, the angle of divergence of the veins is intermediate to that of the two other species, and all except the upper pairs are twice forked.

Habitat—Nodules of Mazon creek; found also in the mammoth vein of Raush Gap, Penn'a.

PECOPTERIS ELLIPTICA, *Bunb'y, Pl. XXXIX, Figs. 4–6.*

Bunb'y, Quart. Journ., Geol. Soc. 1845, p. 82, Pl. VII.

Fronds large, bipinnate; secondary divisions linear-lanceolate, narrowed at the apex to a nearly round or obovate pinnule; lateral leaflets oblong or ovate, distant, rounded at base to the point of attachment; medial nerve thick; veins forked once at the base, the lower ones forking again near the borders, oblique and curved; fructifications in two to four rows of round sori parallel to the medial nerve.

The species distinct, and easily recognized, preserves its characters in all its parts, as well on fertile as on sterile specimens. The pinnæ or fronds are large, thirty centimeters or more; the secondary divisions distant, turned upwards, the lower ones five centimeters long, gradually shorter towards the apex, with pinnules oblique, distant, attached to the rachis by half the base only, the borders on both sides being rounded to the point of attachment. The nervation is always as figured, the medial nerve thick, abruptly effaced under the apex; the veins generally obsolete, covered by a thick epidermis, only very distinct when the epidermis is erased. The fructified pinnules somewhat broader, bear one or two rows of round sori on each side of the medial nerve both the inside rows of six or seven sori being quite close to it. The author's figure, l. c., shows five rows of sori upon the pinnules. I have not seen more than four, and when only two or three, one of them is generally quite close to the midrib, even as it attached to its borders.

Habitat—Tremont, New Vein. The species is also in numerous large sterile and fructified specimens, in the collection of Mr. Lacoe, from Oliphant, vein No. 1.

PECOPTERIS DISTANS, *Lesqx.*

Boston Journ. S. N. H., v. VI, p. 423. Geol. of Penn'a, 1858, p. 866, Pl. XI, f. 3. Schp. Paleont. veget., I, p. 506.

Ultimate pinnæ long, linear-lanceolate, flexuous or recurved; pinnules distant, rounded at base, oblong, narrowed to an obtuse point; medial nerve thick, gradually effaced in dividing above the middle; veins distinct, forking once above the middle.

As remarked in the description of this Fern, l. c., it is closely allied by its characters to *P. elliptica*, and may be a variety of it. The pinnules are narrower, still more distant, the substance not as thick and the veins quite distinct, forked only once.

Habitat—Shale of the Muddy Creek coal, between Pottsville and Tremont, Penn'a.

PECOPTERIS MILTONI, *Brgt. Pl. XLI, Fig 9.*

Brgt. Hist. d. veg. foss., p. 333, Pl. CXIV.

P. polymorpha, Brgt., ibid., p. 331, Pl. CXIII. Lesqx., Geol. of Penn'a, 1858, p. 866. Schp., Paleont. veget., I, p. 506.

Cyatheites Miltoni, Gein., Verst., p. 27, Pl. XXX, f. 5–8; XXXI, f. 1–4. Schp., Paleont. veget., I, p. 506.

Frond very large; rachis thick, smooth obscurely striate; ultimate pinnæ nearly in right angle, somewhat curving upwards, longer in the middle of the pinnæ, linear-lanceolate, gradually narrower to the small terminal ovate leaflets; pinnules connate or disjoined at the slightly narrowed base, contiguous on the borders, oblong, obtuse; medial nerve distinct to below the apex; veins in a broad angle of divergence, generally forked twice, very close, distinct, joining the borders in right angle.

This diagnosis is made from the middle part of a pinna, thirty centimeters long, the upper and lower part destroyed, with the rachis eight millimeters broad, half cylindrical. The lateral pinnæ are all simple, nine centimeters long in the middle of the primary ones, only six towards the base, with pinnules all entire as described. This Fern like all the *Pecopterids* is extremely variable in the different parts of its fronds. Often the lower ultimate pinna becomes enlarged at the base, bipinnate, the pinnules being first undulate on the borders, then distinctly subdivided in small half round pinnules similar in shape to f. 6 of Pl. XLVI, where I have represented the various forms under which most of the species of *Pecopteris* of this division are seen.

There is a diversity of opinion in regard to the relation of *P. Miltoni* to *P. polymorpha*. Schimper considers them as different species, remarking that it is however extremely difficult to separate them. Goeppert and Geinitz unite them in one, as I have done also in Geol. of Penn'a, l. c. Weiss and Heer do the same.

Habitat—Upper coal measures, horizon of the Pittsburg coal. Salem vein of the Tunnel near Tremont, in fine specimens. Gate vein near Pottsville, and Muddy Creek; also near the Wabash river, below New Harmony, Ind., and at Grayville, Ill. It seems to follow *P. arborescens* in its distribution.

PECOPTERIS ABBREVIATA? *Brgt., Pl. XLVI, Figs. 4–6.*

Brgt., Hist. d. veg. foss., p. 337, Pl. CXV, f. 1–4. Lesqx., Geol. of Penn'a, 1858, p. 867. Geol. Rept. of Ill., IV, p. 403.

Pecopteris polymorpha, Schp., Paleont. veget., I, p. 506.

Cyatheites Miltoni, Gein., Verst., p. 27, Pl. XXX, f. 7, 8.

Frond diversely pinnately divided; pinnæ lanceolate, narrow; ultimate divisions slightly oblique, from a cylindrical smooth rachis, linear-lanceolate; pinnules of the upper pinnæ ovate, obtuse, connate at the base; those of the lower pinnæ longer, pinnately lobed or undulate on the borders; medial nerve thin, effaced under the apex; lateral veins distinctly inflated, forking twice.

The form and size of the pinnæ, is variable according to their position upon the fronds. F. 4 and 5 are the upper parts of lanceolate pinnæ with short divisions and pinnules entire, connate near the base, gradually shorter near the apex where they become confluent to the terminal comparatively large half round leaflet. These pinnules are all entire in the upper pinnæ; but near the base, f. 5, they become already regularly undulate, and in f. 6, probably a lower fragment of the same pinna, the leaflets are more distinctly pinnately lobed and each lobe has its separated venation as marked f. *5a*, *5b*, showing a group of veinlets forking once or twice and curved in passing to the borders of the lobes. The veins are distinctly and sometimes remarkably thick, but irregularly so; for some of them are inflated towards the base, or near the borders while others preserve in their whole length the average thickness. None of the specimens has any distinct fructifications; some leaflets as f. *5b* are irregularly dotted with small points, which do not appear organic, or are not in shape and regularity of position analogous to the sori figured and described by Geinitz, l. c.

Though all the characters of this plant are in some concordance with those described and figured by Brongniart, Geinitz and other authors of *P. abbreviata*, it is not certain that our specimens represent the same species, none of the authors remarking on the remarkable inflation of the veins. Geinitz has figured them Pl. XXX, f. *7a* comparatively thick towards the base, like those of his Pl. XXXI, f. 2, which he refers to *P. Miltoni;* but he gives the same character in most of the enlarged figures of species of *Pecopteris*, and therefore it is merely the size represented by the enlarging glass; while in the plant described here, the inflation of the veins is distinctly seen with the naked eye; and not merely basilar, but often stronger towards the borders. This form cannot be referred to *P. Miltoni* as a variety, for it is common in the nodules of Mazon Creek, where no remains with the normal characters of *P. Miltoni*, or *P. polymorpha*, have been seen. The specimen mentioned Geol. of Penn'a l. c., with veinlets obsolete, might be referable to this last species.

Habitat—Mazon Creek in nodules.

PECOPTERIS PTEROIDES, *Brgt.*

Hist. d. veg. foss., p. 329, Pl. XCIX, f. 1. Andræ, in Germ. Verst., p. 103, Pl. XXXVI. Lesqx. Geol. Rept. of Ill., II, p. 441. Schp., Paleont. Veget., 1, p. 508.

Frond tripinnate; rachis thick, smooth; pinnæ narrow, lanceolate; lateral divisions short, oblique, close, sessile, linear, obtuse; pinnules oblong, obtuse, connate at the base contiguous in half their length, oblique; medial nerve thin, effaced above the middle; veins forking once near the base, the branches, either both or one of them, forking again near the border; fructified pinnæ longer, with pinnules distinct to the base, even distant, sessile by the whole base, bearing near each border and parallel to them one row of twelve to fourteen round sori, not confluent, composed of five oval sporanges placed star-like around a central point.

Brongniart says of this species that it is so intimately related to *P. Miltoni* that it is separated with difficulty. I refer to it a large number of specimens which partly agree, by the sterile branches, with the author's description, and by the fructification with the figures of *Asterocarpus radiatus*, Goepp., which Geinitz supposes the fruiting part of this species. The lateral pinnæ are short, five centimeters in the middle of the fronds, the pinnules sometimes free and rounded to the base, sometimes connate to above the middle; their substance is thick, the medial nerve thin and the veins mostly twice forked. It is indeed difficult to separate this and the former species by characters which present so few points of difference. Brongniart however had not seen the fructifications and it is especially on this point that both plants are unlike. In all the fertile specimens of *P. Miltoni*, the sori are round, inflated but not open, and the distribution of the sporanges not distinct as it is in this species or as in *Asterocarpus.*

Habitat—Pomeroy, Ohio, there very abundant. A specimen from Mazon Creek mentioned in the Geol. Rept. of Ill., loc. cit., has no fruit, and its relation to the species is not positive.

PECOPTERIS (VILLOUS).

PECOPTERIS VELUTINA, *Lesqx.*

Boston Jour. S. N. H., v. VI, p. 423. Geol. of Penn'a, 1858, p. 866, Pl. XII, f. 3. Schp. Paleont, veget., I, p. 509.

Frond bipinnate; rachis thick, flat, smooth; primary pinnæ lanceolate; lateral divisions nearly in right angle slightly flexuous, short and distant, sessile; pinnules ovate, enlarged above the base, rounded and slightly narrowed to the point of attachment, disconnected and distant in the lower part of the pinnæ, more and more confluent in the upper part, passing to lobed terminal pinnules; epidermis thick, punctulate, rendering the venation obsolete; fructifications in two rows of three to four distant sori in the upper part of the leaflets.

The specimen represents a pinna twenty-four centimeters long, with flat smooth rachis seven millimeters broad at the base, where it is broken, bearing lateral branches, five centimeters long in the middle of the leaf, somewhat shorter towards the base. The pinnules averaging six millimeters long and four broad near the base, are contracted from the middle into an obtuse or blunt apex, and bear, in the narrow part, two rows of large sori, two to four, between the medial nerve and the border. In the specimen figured Geol. of Penn'a, l. c., the only one I had seen then, the medial nerve is distinctly marked by a furrow, but the venation is totally obsolete under the thick punctate epidermis which, however to the eyes, appears smooth or polished. Another specimen recently obtained from Cannelton bears a bipinnate leaf, with short oblong pinnæ, abruptly narrowed into small triangular terminal pinnules, coalescent with the two upper pairs of the lateral ones, as in the figured specimen. The lateral pinnules are however smaller, less distant, regularly oblong-obtuse, attached in right angle to a broad flat rachis. They have also a thick, shining epidermis, covered with very small dots. On a few of them, in a more advanced stage of maceration, the veins are perceivable, coming off from the medial nerve in an acute angle of divergence, even decurring at the base, curving abruptly from the middle to the borders, which they join in right angle, forking once near the base and one of the branches of the lowest pair forking once again.

Habitat—Johnstown, Penn'a, in a bed of black soft shale near the base of the middle coal measures. Cannelton coal, Mr. I. F. Mansfield.

PECOPTERIS CLINTONI, *Sp. nov., Pl. XLII, Figs. 1–5b.*

Frond large, polypinnate; rachis smooth, striate; pinnæ lanceolate, bi or tripinnatified; ultimate divisions lanceolate or linear, obtuse; pinnules connate at the base either distant and decurrent, deeply pinnately lobed, or merely oblique, contiguous, simple, entire or crenulate; medial nerve thick towards the base, effaced above the middle; veins buried into the villous or hairy epidermis, indistinctly seen, very oblique to the medial nerve, scarcely curved, forked once or twice; fructifications in two rows of close transversely oval sori, covering the whole surface of the pinnules.

This Fern, known by a number of finely preserved fragments, is extremely variable, especially in the shape of the pinnules. In the large branches near the base of the fronds, the lateral pinnæ, curved upwards, are regularly divided in large pinnules, connate at the base, contiguous, oblique, either undulately lobed or crenate, all oblong-obtuse, one to two centimeters long. f. 3. Higher up these pinnæ are more flexuous, and the pinnules, more distant, become more deeply irregularly, pinnately lobed and decurrent at the base, f. 1, while near the apex, as in f. 2, the pinnules are short, entire, oblong, oblique, slightly decurring, becoming confluent near the top. F. 4 is a lower lateral pinna, inferior to those at the base of f. 3. Its pinnules, longer and more deeply pinnately lobed, are like divisions of a second degree, rather than those of a third. The fructifications marked f. 5, are in two rows of very close sori, covering the whole leaflets in such a way that the epidermis appears often as destroyed, and the sori as attached to the medial nerve. This is, however, a mere appearance, for in the larger pinnules, the outlines of the leaflets are distinctly marked by a border around the sori.

Habitat—Clinton, Mo.; communicated in numerous specimens, by Dr. J. H. Britts.

PECOPTERIS VESTITA, *Sp. nov.*, *Pl. XLIII, Figs. 1–7.*

Rachis of medium size, scaly or punctulate; pinnæ lanceolate, rapidly tapering to the apex; lateral divisions narrowly lanceolate, slightly broader in the middle, in right angle to the rachis, sessile; pinnules oblique, connate and decurring at the base, rarely contiguous, oblong, obtuse, entire; surface villous or hairy; medial nerve thin; veins forking generally once; fructifications in two rows of distant and oval sori, placed on the forks of the veins.

Though the lateral pinnæ have different forms, according to their position, the facies is generally uniform, and the pinnules merely vary in size, their borders being generally entire, becoming undulate only in the lower pinnæ, as in f. 1, 2. They average one centimeter in length, the longer becoming undulately pinnate in the lower parts, f. 1. They are all inclined outwards, more or less distinctly decurring, and when distant and passing into pinnæ, as in f. 7, the base follows the rachis in a narrow border. This character separates this species from those of this section. The medial nerve is thin and nearly continuous to the apex, generally curved downwards at its base; the veins are once forked; but sometimes, as seen f. 3*a*, the upper branch forks again. The surface is covered with short hairs, a villosity distinctly seen upon all the sterile pinnules, though none appears upon the fertile ones. These, bear in the middle of the lamina, or between the borders and the midrib, two rows of distant oval inflated sori, f. 4, a fragment with the characters, nervation, and shape of leaflets of f. 3.—F. 5, 5*a*, enlarged, seem to be the fructified part of a pinna of the same character as f. 3. The sori are destroyed and their place marked by an oval empty space. There is merely a difference in the closer, more numerous fruit dots, and in the less decurrent base of the leaflets. The rachis of both fructified parts, f. 4 and 5, is much larger than that of the sterile pinnæ.

The relation of this species to *Sphenopteris integra*, Andræ, in Germ., Verst., p. 67, Pl. XXVIII, f. 1–3, is very close. In that species, which has the same shape and disposition of the pinnæ and pinnules, the medial nerve is more distinctly decurring to the rachis, and the lower veins of the upper side are curved in the same way along the rachis to join the base of the medial nerve. The veins, also, are all twice forked, and the surface is apparently smooth. The author does not remark upon this character, but only says that the veins, though thin, are distinct. In our specimen the hairs are longer, more distinct upon the veins, whose disposition is thus recognized. The rachis also is distinctly scaly or dotted with deep points under the cortex.

Habitat—Morris, shale of the coal, in a number of specimens in the collection of the Museum of Comp. Zool. of Cambridge.

PECOPTERIS VILLOSA? *Brgt.*

Hist. d. veg. foss., p. 316, Pl. CIV, f. 3. Lesqx., Geol. Rept. of Ill., II, p. 442; IV, p. 402. Schp. Paleont. veget., I, p. 503.

Cyatheites villosus, Gein. Verst., p. 25, Pl. XXXIX, f. 6–8.

Pecopteris Miltoni, var. pilosa, Gutb., Gæa von Schs., p. 82.

Fronds very large, polypinnate; divisions variable as in the former species; rachis deeply punctulate; pinnules *densely villous, especially upon the lower surface; veins dichotomous, forking once, twice or more.*

This species has in its pinnæ all the diversity of forms remarked in the subdivisions of the *Pecopteris*. For that reason, the reference of its separate fragments is often perplexing. But it is generally possible to compare their characters from a large number of specimens, and thus to recognize the identity of their different forms; for they are derived from Fern-trees of large size, and their branches are often widely spread in the roof shale of some coal beds, even locally distributed without any other kind of vegetable remains. The ultimate pinnæ bear linear obtuse, comparatively long, simple pinnules, or are composed of pinnules whose borders are undulate or more or less distinctly crenate-lobed. The veins are rarely discernible. Neither Brongniart nor Schimper have described their characters. Geinitz figures them simple or forked once. When the epidermis is destroyed by maceration, and the skeleton of the plants preserved, as it is sometimes the case in the nodules of Mazon creek, the veins, then remarkably distinct, are seen, curved to the borders, forking generally twice, with simple branches intermediate to the sub-divisions. The venation is therefore of the same character as that of *P. Milloni*, and it is probably from this that Gutbier considered Brongniart plant as a villous variety of it. The shape of the leaflets not decurring, and the venation separate this species from the other three described above with villous pinnule. The scales are generally destroyed upon the ultimate divisions of the rachis, but the three first subdivisions of the stems are always distinctly marked with deep points.

The rachis towards the base of the fronds is of very large size, some of the fragments measuring five centimeters in diameter, even more. They are recognized by the irregularly scattered dots remaining upon the thick coaly surface, as base of destroyed scales. The dots are variable in size and distribution, the largest, one millimeter in diameter, upraised or with inflated borders, but without any vascular central points.

P. arborescens, also a Fern tree, is, by the subdivisions of its branches, the rachis often punctate, the shape and size of the pinnules, remarkably similar to the species described here as *P. vollosa*, Brgt. The convex, naked (not villous) surface of the pinnules of *P. arborescens*, and the always distinct, and far different venation, offer sufficient evidence for its identification.

As the nervation described from American specimens does not agree with the character indicated by European authors, the identity of this plant is not positively ascertained.

Habitat—Most common in some localities. Nodules of Mazon Creek, Ill.; around Pittston, Penn'a. A collection examined there is composed mostly of specimens of this species in indefinite numbers. Generally found in the lower coal measures.

PECOPTERIS. (CRESTATE.)

PECOPTERIS EROSA, *Gutb., Pl. XLIV, Fig. 1, 3.*

P. erosa and P. linearis, Gutb., Gœa v. Sachsen., p. 81, 83.

Alethopteris erosa, Gein., Verst., p. 29, Pl. XXXII, f. 7–9. Lesqx., Geol. Rept. of Ill., IV, p. 394. Schp., Paleont. Veget., III, p. 501.

Leaf large, long, linear; lateral divisions sessile, alternate, close and narrow, linear, with borders unequally dentate; teeth short, acuminate, more or less distinctly lobate on the side; veins simple, in acute angle fron the rachis, forking in two or three branches near the top; fructifications in large round marginal sori between the branches of the veins.

This species like those of this group is remarkable by its narrow linear pinnæ, in right angle to the rachis, three millimeters broad, two or three centimeters long, with the borders cut into short simple or slightly lobate teeth, turned to the outside, thus similar to the blade of a small saw. The veins, oblique to the rachis, pass up and divide near the border in one or two branches, enteringthe points of the teeth and of the lobes. The fructifications are in broad round sori placed on the borders of the pinnæ and covering the teeth; they appear composed of an irregular agglomeration of punctiform sporanges. The border divisions of the pinnæ and especially the form of the sori are generally obscure and their characters difficult to observe.

Habitat—Morris shale, in large specimens communicated by Mr. S. S. Strong, sterile and fertile; Clinton, Mo., Dr. I. H. Britts, in sterile specimens. Taylorsville, Pa. (E. vein), Mr. R. D. Lacoe.

PECOPTERIS CRISTATA, *Gutb., Pl. 44, Figs. 2, 2a.*

Gutb. Gœa v. Sachen., p. 80.

Alethopteris cristata., Gein., Verst., p. 29., Pl. XXXII, f. 6. Lesqx, Geol. Rept. of Ill., IV, p. 395. Schp., Paleont. Veget., III, p. 501.

Lateral pinnæ more deeply lobate; lobes cut in three or four sharply accuminate teeth; veins forking from the base, in two or three branches, one or two of them forking again near the borders, all the divisions entering the teeth.

I have not been able to find positive and persistent characters to separate this form. When in *P. erosa*, the lobes are more enlarged, as it is the case in the lower pinnæ, f. 1*a*, these lobes become more deeply and distinctly divided, cut in three or four sharply acuminate teeth. The medial vein is then also proportionally more divided, as the teeth are formed each, by the prolongation of the lamina to the points of the veins or of their branches. I have figured, 2*a*, the enlarged portion of f. 2, which, I believe, represents in its characters the form described and figured by Geinitz as *P. cristata*, and which seems to be a mere variety of *P. erosa*. It may be however that I do not know the true *Alethopteris cristata* of Geinitz, who represents the borders larger than those of the fragment f. 2. In this specimen the pinnæ are not broader than those of the former species.

Habitat—Cannelton a large well preserved specimen. None with the characters of *P. erosa* have been found there.

PECOPTERIS SERRULA, *Lesqx.*

Alethopteris serrula, Lesqx., Geol. of Penn'a, 1858, p. 865, Pl. XII, f. 1. Pecopteris serrula, Schp., Paleont, veget., 1, p. 525.

Leaf of large size, lanceolate; lateral pinnæ sessile, *alternate, flexuous, inclined upwards or downwards, long, linear; borders cut in short obtuse obscurely tridentate lobes; veins oblique from the broad rachis, alternately forking or dichotomous.*

This species has a remarkable likeness to *P. erosa.* It especially differs by the great length of the flexuous pinnæ, the lower ones ten centimeters long, the upper six centimeters; by the less acute teeth of the borders, (represented too sharply dentate upon the enlarged f. 1*a*), which are merely undulate, all equal, and by the dichotomous venation. In *P. erosa*, the lower divisions of the pinnæ joining the main rachis are always longer and the teeth more acute. In this species they are all equal, merely gradually shorter toward the apex of the pinnæ, the terminal pinnules being small taper-pointed. The pinnæ are five millimeters broad in joining the rachis and only two millimeters near the apex. The ultimate rachis is narrower than in *P. erosa.* As Schimper remarks it, the species is in close relation to *P. angustissima*, Brgt., whose pinnæ are linear and equally narrow, but with entire lobes.

Habitat—Shale of an old vein behind the hills east of Port Carbon, Pa., with *Sigillaria Brardii.* Not found elsewhere.

PECOPTERIS ANGUSTISSIMA? *Brgt., Pl. XXX, Figs. 5, 5a.*

Brgt., Hist. d. veg. foss., p. 343, Pl. CXX, f. 5. Schp., Paleont. veget., 1, p. 518.

Aspidium angustissimum, St., Flor. d. Vorw., I, p. 29, Pl. XXIII, f. 1.

Leaf bipinnate; pinnæ close, short, narrow, in right angle, or curving backward; borders pinnately lobed; divisions half way to the rachis, obtuse, entire; nerves curved at base to the rachis, forked once on each side near the top, with a separate branch passing in a curve from the base of the medial nerve to the acute sinuses.

This fragment seems to represent Sternberg's plant, which is merely known by its figure l. c. and the reproduction of the same by Brongniart. The pinnæ of the American plant have, in shape and size, the same characters as the European species, and are placed at the same distance; both the secondary and tertiary rachis also are of the same thickness. But the veins are generally forked near the borders and the lower ones curved outward toward the sinuses, with the medial vein curved downward and slightly decurring to the rachis. The figure given by Sternberg shows the primary veins only slightly oblique to the rachis and merely forking near its top, and Brongniart represents them simple, describing them from the figure of Sternberg who does not mention their characters, which, indeed, are ascertained with great difficulty in pinnules as small as are those of this species. The primary rachis of the European plant bears long filiform spines; no fragments of organs of this kind are preserved upon the only specimen I had for examination. The substance of the leaflets is apparently membranaceous, somewhat pellucid.

Habitat—Helena mines, Ala. Collection of the State Geol. survey. The European plant is derived from the coal mines of Swina.

PECOPTERIS HALLII, *Lesqx.*

Geol. Rept. of Ill., IV, p. 394, Pl. X, f. 7, 8. Allethopteris Hallii, Lesq.

Leaf bipinnate; pinnæ in right angle to the straight cylindrical rachis, linear, alternate, close, apparently short, merely undulately lobate on the borders, or with lobes truncate or emarginate at the apex; primary veins curving to the rachis, forked once in the middle and once more near the borders, the branches reaching the middle of the sinuses.

Species related to *P. serrula*, especially differing by the short pinnæ and the disposition of the veins joining the border in the middle of the sinuses. I believe however that this last character which is an anomaly in the venation of the Ferns of this group is merely apparent. The borders appear inflated or incurved and probably the veins may tend to the reflexed point only touching the sinuses in passing up. The form of the divisions of the borders and also the end of the veins are obscure and uncertain. I remarked in describing this form that it might represent the sterile part of *P. serrula*, while the specimen described under this name might be that of a fertile pinna. The species is as yet uncertain, and possibly the three last described forms may be recognized as identical when more complete specimens are found.

Habitat—Mazon Creek in nodules. The museum of Cambridge has a fine large specimen (Al. 145) which is more distinct, and far better preserved than the one from which the figure and description of the Ill. Rept. is made.

PECOPTERIS LYRATIFOLIA, *Goepp., Pl. XLVIII, Figs. 4–5b.*

Sphenopteris lyratifolia, Geopp., Gatt., III, IV, p. 71, Pl. XIII. Weiss Foss. fl., p. 48, Pl. 7, f. 2. Schp., Paleont. veget., 1, p. 376.

Frond tripinnate; pinnæ linear-lanceolate, with a broad rachis inflated in the middle, flattened on the borders; lateral divisions oblique, linear, pinnately lobed; lobes short, oblong, obtuse, inclined outward, connate to near the middle; medial nerve narrow, subdecurrent at base, pinnately forked in simple branches; fructifications in round sori of five to six small globular sporanges placed upon the branches of the veins close to the borders.

Though the fragment f. 5, is only part of a tripinnate frond, as seen from the beautiful specimens figured by Goeppert and Weiss, its reference to the European species is evident. The essential characters of the Fern, the thickness of the rachis, and its divisions, inflated in the middle; the shape of the lobes, their relative position, the thick epidermis, the mode of decurrence of the secondary rachis etc., are the same. The lower pinnules of the inferior side are generally attached to the main rachis; the others, averaging five millimeters long, are disposed in five to six pairs, and either opposite or alternate, according to their angle of divergence, generally oblong-obtuse, sometimes slightly contracted in the middle. The venation is rendered obsolete by the thick epidermis, which appears somewhat scaly as seen f. 5*a*, and the veins are distinct only upon the impression of the lower surface. The medial nerve, inclined at base in joining the rachis, ascends to the upper border, alternately forking twice on each side.

That the fragment f. 4 represents a fructified pinna of this species is quite evident from the structure of the rachis, its mode of division and the shape of the lobes. The sori f. 4*a*, 4*b*, 4*e*, are round, placed upon the apex of the lateral veinlets, close to the borders; the sporanges like small points when seen with the naked eye, are represented enlarged f. 4. By its fructifications this species is referable to the *Cyatheites* rather than to *Cheilantes*.

Habitat—Nodules of Mazon Creek, the fertile specimen, presented by Mr. S. S. Strong; the sterile, from Morris shale, is (SS, 158), in the collection of the Museum Comp. Zool. of Cambridge.

PECOPTERIS STELLATA, *Lesqx., Pl. XLVIII, Figs. 7–7b.*

Alethopteris stellata, Lesqx., Geol. Rept. of Ill., II, p. 440, Pl. XXXVII, f. 4–4b.

Fragment of a pinna, pinnately divided; segments oblique, linear, alternate, obtuse or subtruncate at the apex, decurring to the main rachis or the midrib, bordered by a broad wing undulate on the borders; primary and secondary veins pinnately branching; ultimate divisions simple, oblique, alternate, slightly arched, each bearing at the apex a round six-stellate sporange, placed on the slightly recurved borders.

The small fragment figured represents all that is known of this species. The main lamina of the pinna formed by the decurring base of the segments, is five millimeters broad; that of the segments about three millimeters; the main nerve or partial rachis is thin, as are also its divisions. The substance of the Fern is somewhat thick, the fragments showing the under surface with borders a little reflexed. The sori are formed of six round sporanges around a broad central flat surface, f. 7*b*. Though this species is far different in its facies from most of the *Pecopteris*, the fructifications are of the same type as those of *Asterocarpus*. The segments have a likeness also to those of *P. cristata*.

Habitat—Mazon Creek in Nodules.

PECOPTERIS SOLIDA, *Lesqx., Pl. XLVIII, Figs. 6–6b.*

Alethopteris solida, Lesqx., Geol. Rept. of Ill., IV, p. 397, Pl. XI, f. 5–7.

Fragment simply pinnate; rachis very thick; divisions or pinnules in right angle, attached by the enlarged base of the thick midrib, linear or oblong obtuse, rounded at the base and there slightly enlarged, very entire, coriaceous; veins totally obsolete; fructifications in round distant sori placed in rows near the margins; sporanges of the same form and in the same position as in the former species.

The rachis is flat, comparatively very broad, half a centimeter at least, smooth; the pinnules two to two and a half centimeters long, are gradually shorter towards the upper part of the pinna, about five millimeters broad in the middle, enlarged and rounded on both sides of the equilateral base. The position, shape and constitution of the sori are much the same as in the former species, but no trace of lateral veins is discernible. The midrib is thick and broad and the leaflets seem attached to the rachis merely by its enlarged base.

By the position of the sori and the shape of the leaves this species is comparable to a *Polypodium*, resembling by these characters *Phlebopteris Polypodioides*, Brgt., Hist. d. veg. foss., p. 372. Pl. LXXXIII, f. 1. The analogy is equally marked with some *Dicksoniæ*, of the genus *Spiropteris.*

Habitat—Mazon Creek in concretions.

PECOPTERIS OF UNCERTAIN RELATION.

PECOPTERIS CLARKII, *Sp. nov., Pl. XLI, Fig. 10.*

Frond tripinnatifid; rachis broad, flattened on the borders; primary pinnæ narrowly lanceolate, rigid, slightly oblique; secondary divisions close, alternate, short, linear-lanceolate, obtuse, with a flexous narrow rachis; pinnules oblong, obtuse or half round, connate to the middle; medial veins of the same thickness as the lateral ones which are oblique, alternate, scarcely curved, forking once above the middle.

This Fern is remarkable for its rigid, coriaceous consistence, the pinnules being convex on the upper surface and their impressions deeply carved into the stone, thus exposing its characters very distinctly. The primary pinnæ, ten centimeters long, are straight, rigid, with a narrow rachis, flattened on the borders, and narrowly grooved in the middle. The ultimate pinnæ are short, the lowest, one and a half centimeters long, close, exactly parallel and gradually narrowed toward the apex, where the upper ones become simple and confluent to a very small half round terminal pinnule; the rachis of the lateral pinnæ is flexuous or in zigzag, bending to the base of each bundle of lateral veins; the pinnules small, the largest scarcely three millimeters long and two broad, alternate, connate to the middle, oblong and very obtuse. The veins are not very thick, but deeply marked, the middle one slightly stronger and flexuous near the base.

Habitat—Mount Hope Coal mines, Rhode Island, Mr. J. H. Clark. Only one good specimen found. Another from the nodules of Mazon Creek seems to represent the same species. It is too fragmentary.

PECOPTERIS NOTATA, *Lesqx.*

Boston Jour. S. N. H., v. VI, p. 424. Geol. of Penn'a, 1858, p. 866, Pl. XVIII, f. 4.

Frond tripinnatifid; divisions all nearly in right angle, the primary ones long, linear; secondary pinnæ narrow, parallel, sublinear, obtuse, with a thick flexuous rachis; pinnules slightly oblique, oblong-obtuse, connate to the middle; midrib thin, lateral veins open, the lower ones nearly in right angle, all slightly curved upwards toward the borders, and forking once in the middle; surface of the pinnules punctate.

Besides its large size, this species differs from the former by its thin (at least not coriaceous) substance, by the more open direction of the secondary veins, curved upwards in passing to the borders, and by the punctate surface. The rachis is much stronger, not winged, and the terminal pinnules comparatively larger. The lateral pinnæ are twice as long, nearly exactly linear, the pinnules averaging half a centimeter long and four millimeters broad, being quite as large near the apex as near the base of the pinnæ, excepting however the lower pair which is slightly longer. The dots marked upon the surface are intermediate the veins and their divisons, but not in regular rows. They are very small too small, it seems, to represent sori. They may be points marking the base of scattered scales or hairs. In my first description I considered them as fruit dots.

Compared to *P. oreopteridis*, Brgt., this species differs by the thick flexuous ultimate divisions of the rachis, the pinnules or lobes connate to the middle and the thin lateral veins curving upwards in passing to the borders.

Habitat—Gate vein, near Pottsville. I have not seen another specimen of the same character. The original, from which the plant is described and figured, was in the cabinet of Prof. H. D. Rogers.

PECOPTERIS MICROPHYLLA, *Brgt.*

Hist. d. veg. foss., p. 340, Pl. CXVII, f. 2.

Frond small; primary pinnæ lanceolate; lateral divisions open, linear lanceolate; tertiary pinnæ or pinnules small, somewhat inclined outside, pinnately lobed; medial veins of the lobes distinct, divisions obsolete.

The leaf which I refer to this species is tripinnatifid, the primary pinnæ lanceolate, ten centimeters long, four and a half centimeters broad, linear to the upper part where the specimen is broken; secondary pinnæ linear-lanceolate, close, alternate; tertiary divisions sessile, oblique, even slighly decurring to the rachis, linear, five to six millimeters long, two millimeters broad, pinnately divided into four pairs of lobes in the largest pinnules, passing to three, then to two pairs towards the upper part of the pinnæ where the pinnules become entire at the apex and confluent to a small obtuse leaflet; lobes half round.

The only difference between this Fern and that described by Brongniart is in the lobes, less deeply cut in the American specimen and in the slightly decurring base of the tertiary divisions.

Habitat—Communicated in one specimen only by Mr. Tyler McWorther, of Aledo, Ill., low coal measures, locality not mentioned.

PECOPTERIS INCOMPLETA, *Lesqx.*

Geol. of Penn'a, 1858, p. 868, Pl. I, f. 12, 12a.

Leaf bipinnatifid; pinnæ oblique, curved upwards, narrowly linear-lanceolate; pinnules alternate, oblong, very obtuse, connate near the base, somewhat decurring or much inclined upwards, the upper ones very small on both sides of the rachis, which pass beyond into a naked linear blunt lacinia; medial veins scarcely distinct.

I should have omitted the description of this too small fragment, the characters being too indefinite for a reliable specification. I find, however, a species described as *Sphenopteris coarctata*, in Roehl, Paleont., XVIII, p. 61, Pl. XIV, f. 5, which is very similar to this, especially by the prolongation of the rachis into a linear band, taking the place of a terminal pinnule. In the American species this terminal prolongation of the rachis is longer, five millimeters, one millimeter broad, in its whole length, and obtuse; in the European form, the upper pinules seem abruptly narrowed into a short linear-acuminate apex. The lower pinnules are also shorter in our fragment, more obtuse, very entire; while in Roehl's figure the lower pinnules are lobate at the top, and longer. In these also the medial nerve forks into two branches at the base, while it is simple as far as can be seen in ours. Notwithstanding these differences, the relation of these fragments is very close.

Habilal—Gate vein near Pottsville.

PECOPTERIS CONCINNA, *Lesqx.*

Boston Journ. S. N. H., v. VI, p. 424. Geol. of Penn'a, p. 867, Pl. XI, f. 5. Schp., Paleont. veget., I, p. 507.

Leaf bipinnate; pinnæ allernale, linear-lanceolate, open, *distant, with a narrow, flexuous rachis; pinnules distant, oblong, narrowed upwards to an obtuse apex, rounded to the point of attachment; borders pinnately undulate or lobate; medial nerve alternately branching; veins dichotomous.*

The fragment does not show the lateral pinnæ in their whole. They appear linear, lanceolate toward the apex, the pinnules becoming gradually shorter upwards, their length, one centimeter near the base of the pinnæ, being eight millimeters at a distance of two and a half centimeters from the main rachis, where the pinnæ are broken. The pinnules are oblong or narrowly oval, equally narrowed at both ends, and regularly pinnately undulate or rather lobate, as each secondary division of the veins constitutes a group of veinlets for each lobe, by a medial vein pinnately divided into four or five alternate branches.

Habitat—Gate vein, near Pottsville. The fragment is on the same shale as *Pseudopecopteris decurrens*, and is unique.

OLIGOCARPIA, *Goepp.*

Fronds bipinnate or tripinnatifid; primary pinnæ oblong-lanceolate; secondary divisions open, linear, pinnately divided in oblong or half round lobes or leaflets, connate at the base, crenulate; primary and secondary veins nearly of the same size, thin, but distinct; lateral veins curved to the borders, simple or forked.

This genus, leaving out the characters of fructification, from which its name is derived, but which have not yet been observed on any American specimens clearly enough for microscopical anatomy, is intermediate between the *Pecopterids* and the *Sphenopterids.* The division of the pinnæ, the shape and position of the pinnules, refer the species described here to *Pecopteris*, while the thin nervation and the crenulations of the borders indicate their affinity to *Sphenopteris.*

OLIGOCARPIA ALABAMENSIS, *Lesqx, Pl. XLVII, Figs. 1–1b.*

Sphenopteris Alabamensis, Lesqx., Geol. Rept. of Alabama, 1875, p. 76.

Leaf tripinnatifid, large, slender; primary divisions sub-opposite, distant, open; secondary pinnæ sessile, in right angle, slightly flexuous, alternately pinnately lobed; lobes or pinnules oblong, obtuse, subcrenulate, connate near the base; medial nerve gradually effaced towards the apex by division; veins oblique, curving to the borders, simple or forking above the middle.

The primary and secondary rachis of this species are cylindrical, solid, but not rigid; the primary pinnæ pedicelled, long, sixteen to seventeen centimeters, are broader in the middle, where the secondary divisions measure three and a half centimeters or more, while those of the base are only half as long, also gradually shorter from the middle to the apex. The lobes of the ultimate pinnæ, also slightly larger in the middle, there four millimeters long, half as broad, become very gradually shorter up to the terminal, oblong, small, distinct pinnule. The substance of the leaflets is thin, membranaceous; the veins are distinctly traced upon the yellowish epidermis.

Comparing this and the following species, the relation of the plants is evident.

Habitat—Helena coal mines, Shelby county, Alabama. Prof. Eug. A. Smith.

OLIGOCARPIA GUTBIERI, *Goepp., Pl. XLVIII, Figs. 1–3b.*

Goepp., Gatt. I, II, p. 3, Pl. IV, f. 1, 2. Gein., Verst., p. 30, Pl. XXXIII, f. 6, 7. Pl. XXXV, f. 9. Schp., Paleont., Veget., I, p. 586.

Pinnæ oval-oblong; lateral divisions nearly in right angle, alternate, longer in the middle, lineal, obtuse; pinnules half round, connate to the middle, crenulate; primary veins slightly flexuous, thin, pinnately forking, the lateral forking once again.

F. 3*a*, 3*b*, showing in detail the fructifications, are copied from Geinitz's splendid illustration of this species. Some of our specimens are fruiting; but none of them have the fructifications distinct enough to show by anatomy the details of their characters. Per contra, the branch f. 1, of our plate, is the only one of this species seen until now in its integrity. It has more distinctly an ovel shape than the pinnæ of the former species. Its lateral divisions two and a half centimeters long in the middle, not even half as long at the base, more rapidly shorter to the obtuse apex, have the lobes short, half round. The nervation has the same character as seen f. 2*a*, made from American specimens, and still more f. 3*a*, copied from Geinitz, which has the lobes somewhat longer and cut to near the base. The substance of the pinnules is thin, pale-colored, membranaceous.

Habitat—A few fragmentary specimens have been communicated from Morris, on clay shale, and from Mazon creek, in nodules. The best one, part of which is figured here, comes from Vandalia shaft, Ill., 366 feet below the surface, communicated by Prof. A. H. Worthen.

OLIGOCARPIA FLAGELLARIS, *Lesqx.*

Sphenopteris flagellaris, Lesqx , Boston Journ., S. N. H., v. VI, p. 420, Geol. of Penn'a, 1858, p. 862, Pl. XVIII, f. 1, 1a.

Fragment of leaf bipinnatifid; main rachis cylindrical; pinnæ oblique, long, flexuous, sessile; pinnules deltoid-ovate, crenulate, connate to the middle and decurring, the lower ones half attached to the main rachis; medial veins flexuous, divisions simple or forked once.

The flexuous pinnæ, seven centimeters long, are narrow, linear; the pinnules slightly short towards the base, and also towards the terminal small obtuse pinnules, are three to four millimeters long and as broad below the middle, where they become decurring or turned downwards and connate. The nervation and the substance of the leaflets is thin, the veins distinct and slender as in the species described above. The lobes are rather blunt or somewhat acute than obtuse, deltoid.

Habitat—South Salem vein, Tunnel of Sharp mountain, near Pottsville. No other specimens have been found but the one figured.

SPHENOPTERIDS.

Fronds bi, tri, polypinnate; divisions open or in right angle; pinnules narrowed at base, often decurring or cuneiform, pinnately lobed; lobes rarely entire, crenulate, dentate or laciniate; primary nerve (medial nerve of the pinnules) slender, alternately dichotomous, simple branches entering the base of each lobe to pass by branchlets into the subdivisions of the lamina. In the genus Eremopteris, the lateral veins enter the lobes in acute angle of divergence from the midrib and, passing up to the borders, are flabellate, dichotomous, parallel and close, as in species of Neuropteris.

Little is known until now of the fructifications of the *Sphenopteris* of the coal. We have few species described with their fruits in this Flora, and they are mostly of different type. The descriptions of the species of this genus are, therefore, generally derived from the subdivisions of the fronds, the shape of the pinnules, and their venation. These, especially the forms of the leaflets and the distribution of the veins, are so extremely diversified, even on fragments of the same species, that it is difficult to find common and permanent characters applicable to a grouping of these Ferns. In order to facilitate their determination, I have separated the *Sphenopterids* in three sections.

Sphenopteris (*Pecopterid.*). Fronds with ultimate pinnæ pinnately deeply lobed, the lobes connate to the middle or higher, the veins pinnately divided, as in *Pecopteris*. Some of the species of this group were referred to *Pecopteris* by Brongniart.

Sphenopteris (*proper*). Pinnæ more deeply divided in lobes or pinnules narrowed and decurring at base, generally dentate or crenate at the apex,

Sphenopteris (*hymenophyllites*.) The characters are indicated and detailed in the description of the group which has been considered with reason, I think, as a distinct genus.

Eremopteris, separated from *Sphenopteris*, by Schimper is a transitional division, passing to *Triphyllopteris*, of the same author, or to the peculiar order of the *Adiantites*, which has been more generally united to the *Neuropterids*. The fructifications of *Archæopteris*, the more important genus of the *Adiantites* are far different from those of the *Neuropterids*, indeed from any other of the Ferns of the coal, excepting only those described and figured by Stur as *Calymnotheca Strangeri*, a species of *Sphenopteris* related to *S. Hœninghausii*. But considering moreover the shape of the leaflets narrowed to a decurring base, the affinity of the plants seems more distinctly marked with *Sphenopteris*. Indeed the species described as *Archæopteris Bockschiana Bochsiana* is sphenopterid by the divisions of the pinnæ and the form of its pinnules; it could be described as *Sphenopteris*, but not as *Neuropteris*.

SPHENOPTERIS. (PECOPTERID.)

SPHENOPTERIS GONIOPTEROIDES, *Sp. nov.*, *Pl. LV, Figs. 3–4a.*

Leaf bipinnate; pinnæ lanceolate; pinnules open, connate by a decurring base, pinnately lobed; lobes distinct, to the middle, deltoid, acute or blunt at the apex; borders equally dentate; medial veins pinnately forking; veinlets simple or the lower sometimes forking, curved inward; divisions entering the teeth.

This species is not sufficiently known. The shape of the pinnules narrowed at the base and decurring to a marginate rachis, refer it to *Sphenopteris*. The veins simple or forked, straight or curved inward relate it to *Goniopteris*. The pinnules are linear-lanceolate, more rapidly narrowed toward the apex; the lower three centimeters long and one centimeter broad or less. In f. 4, the lobes of the pinnules are smaller, more deeply cut, and the lateral veins, all simple, are straight up to the point of the teeth or somewhat curved upward. In f. 3*a* the lower veins are forked. The lower pinnules are alternately six to seven lobed; the lobes, deltoid at the apex, acute and gradually shorter upward, become confluent into mere teeth in passing to very small obtuse terminal pinnules.

Habitat—Cannelton, Penn'a, Mr. I. F. Mansfield.

SPHENOPTERIS CHÆROPHYLLOIDES, *St.*

Fl. d. Vorw., II, p. 131. Schp., Paleont. veget., I, p. 398.

Pecopteris chærophylloides, Brgt., Hist. d. veg. foss., p. 357, Pl. CXXV, f. 1–2.

Leaf bipinnate; pinnæ open, long, linear or lanceolate in the upper part; pinnules linear-lanceolate, oblique, close and parallel, deeply pinnately lobed, lobes distinct to the middle, obscurely dentate; primary nerves distinct to the apex, flexuous; lateral veins forked.

One of our specimens, apparently the base of a large frond, has the primary pinnæ in right angle, sixteen centimeters long, and linear to the point where they are broken, parallel. Primary and secondary rachis narrow, rigid, the last with a very narrow border, preceivable only at the base of the pinnules. Other specimens represent the species with shorter lanceolate pinnæ, and the lobes of the pinnules more deeply cut and narrower, as in f. 2 of Brongniart, l. c.

Fructified pinnæ have the same characters as the sterile fragments, the pinnules are only shorter and narrower and the lobes less distinctly dentate, rather merely undulate-crenate; all the veins are thick, the medial flexuous, the lateral forking in the middle, and the fructifications, round sori, are placed upon the lower branches which abruptly end in the middle of the laminæ. The specimen, a very fine one, shows the upper surface, not only bossed, but very often pierced through by compression upon the sori, which, where the epidermis, is destroyed, appear as composed of four or five large cuneiform poranges placed around a central point, as represented for *Oligocarpia Gutbieri* by Goeppert and Geinitz, Atl., Pl. XLVIII, f. 3*a*, 3*b*.

Brongniart says that the substance of this Fern is thin. In all the specimens preserved in the nodules, it appears on the contrary thick, rather coriaceous, and positively so, for the fructified pinnæ. He describes also the secondary rachis as flexuous, margined by the decurring base of the pinnules, while all the divisions of the Fern which I refer to the species, are rigid and the borders of the rachis are scarcely preceivable except at the point of union of the pinnules. Therefore the American form may represent a species different from that of Europe. In the nodules, however, where the remains of plants have been preserved in their original shape, and not deformed by prolonged decomposition and compression, the rigidity of the branches and the substance of the leaflets, cannot be considered as important characters. In a more advanced stage of decomposition, the rachis may become more distinctly margined by compression, and the pinnæ flexuous.

This species related to the former, differs by the broader more obtuse lobes of the pinnules, the lateral veins generally forked, the secondary rachis scarcely or indistinctly margined, etc.

Habitat—Nodules of Mazon Creek in good specimens; found also in the coal shale of Morris, Ill.

SPHENOPTERIS MEDIANA, *Lesqx.*

*S. intermedia,** *Lesqx., Boston Jour. S. N. H., v. VI, p. 419. Geol. of Penn'a, 1858, p. 862, Pl. VIII, f. 8–9a.*

Leaf bipinnate; primary rachis thick, obscurely channeled; pinnæ oblique, parallel, close, on a narrow smooth naked rachis; pinnules distinct, oblique, parallel, sessile, linear, abruptly narrowed to the apex, equally pinnately lobed; lobes half round, cut to the middle, crenulate; medial veins three or four times dichotomous, very thin, branches simple.

This species is distinct from the former by its shorter, more obtuse lobes and the medial nerve less divided. The pinnules are more distinctly linear and abruptly narrowed to a very small, ovate, crenulate terminal lobe.

Habitat—It is not rare in the lower beds of the Anthracite fields of Penn'a. Also found in the nodules of Morris.

SPHENOPTERIS PSEUDO–MURRAYANA, *Sp. nov.*

Pecopteris Murrayana, Lesqx., Geol., Rept. of Ill., II, p. 443.

Leaf bi, tripinnatifid; primary pinnæ in right angle, linear or oblong-lanceolate, with a narrow rigid rachis;

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*Name pre-occupied by d'Ettingshausen; Steinkohlen flora v. Stradonitz, 1852.

pinnules alternate, open, abruptly narrowed at base and decurring on the rachis by a narrow border, pinnately lobed; lobes cut to below the middle, entire, obtuse, primary nerves straight, lateral veins flexuous, alternate, forking four times in the lowest largest lobes, thrice or twice only in the upper ones; veinlets simple.

Except that the rachis is not flexuous, and that the pinnules, abruptly narrowed at the base, are decurring to a narrow border, this Fern is exactly similar to *Pecopteris Murrayana*, Brgt., as described Hist. d. veg. foss., p. 358, Pl. CXXVI, f. 1, 1*a* and has the same character of nervation. None of our specimens, however, have the lobes of the pinnules cut to the base and distinct as in f. 2 and 3, of the same plate. The pinnæ are variable in length and the pinnules also accordingly, the lobes, three to six pairs on each side, being generally separated to the middle and there confluent or merely joined in a narrow sinus.

Brongniart remarks in his description, that he has received from true carboniferous measures, fragments of a Fern which appear identical with his species described from Jurassic sterile specimens and which now, known by its fructification, is a plant of a far different type than any of those of the coal measures. It is probable that the one described here and which, as seen, from specimens of different localities has always identical characters, is the same observed by the French author from imperfect specimens of the European carboniferous.

The first four species of this group intermediate in their characters between *Pecopteris* and *Sphenopteris* are especially related to the genus *Oligocarpia*.

Habitat—Nodules of Mazon Creek, Ill.; shales of Mount Hope coal, Rhode Island.

SPHENOPTERIS SUBALATA, *Weiss., Pl. LV, Figs. 1, 1a.*

Weiss, foss. fl., p. 57. Schp., Paleont. Veget., III, p. 466.

Hymenophyllites alatus? Gein., Verst., p. 18, Pl. XXIV, f. 15. Lesqx., Geol. Rept. of Ill., II, p. 437, Pl. XXXIX, f. 1.

Frond tripinnate, dichotomous in the upper part, triangular in outline; primary rachis large, distinctly punc-

tate, winged in its ultimate divisions; primary pinnæ open, curved upward, lineal-lanceolate; pinnules in right angle or oblique, contracted and decurring at base, ovate, obtuse, pinnately lobed; lobes dentate; divisions of the lateral veins entering the teeth.

This plant has been for a long time referred to *Pecopteris alata*, Brgt., Hist. d. veg. foss., p. 361, Pl. CXXVII. As may be seen in comparing our f. 1 with the one in Brgt., made from New Holland specimens, there is no other perceivable difference except in the smaller size of the pinnules, the rough rachis and the furcate division on the upper part of the fronds. The form of the pinnules and the nervation are the same. The lower lobes are generally shorter in the American plant, but the difference as also the small size of the pinnules, were supposed to be merely casual or from different parts of the frond. Variations of this kind are observed upon a number of specimens from Cannelton where the species is not rare. The rachis also though generally punctate appears sometimes smooth. The points marked upon it are equally distinct upon the whole upper surface of some specimens, rachis and pinnules. They are acute, distinct, round dots, irregular in position, like those seen upon the surface of some living Ferns. The division of the fronds is the same as in species of *Pseudopecopteris*, with sori placed at the point of the veinlets, top of the teeth. At least Geinitz's figure, l. c., represents a fructified specimen with this character. As this is the only European specimen positively referred to this species by Weiss and Schimper—for the sterile plant, described as the same by Geinitz, is evidently of a different character, we have no sufficient means of comparison.

Habitat—Mazon Creek, in nodules, and Cannelton, in shale, not rare.

SPHENOPTERIS CRISTATA, *St.*

Flor. d. Vorw., II, p. 131. Schimp., Paleont. Veget., 1, p. 397.
Pecopteris cristata, Brgt., Hist. d. veg. foss., p. 356, Pl. CXXV, f. 4, 5.

Frond bipinnate; pinnæ slightly oblique, sub-linear *lanceolate, close, parallel; pinnules oblong or lanceolate, obtuse, contracted at the base, pinnately lobed, lobes short, obtuse, tridentate at the apex, the lower ones quadridentate; veins tri or quadrifid.*

This species has some of the characters of the former. It is much smaller in all its parts; the rachis both primary and secondary are rigid, though very narrow; the secondary one is narrowly winged by the decurring base of the pinnules. These, five to six millimeters long only, are pinnately four to five lobed, the lobes very short, cut at the top in three, rarely four obtuse short teeth, entered by the divisions of the veins. Except that the pinnæ are shorter, our specimen very distinctly preserved in all its parts agrees in full with the description and figure of Brongniart. The fragment, however, described under this name by Geinitz, Verst., p. 16, Pl. XXIV, f. 1, does not appear referable to it, being especially different by its very thick primary and secondary rachis.

Habitat—The best specimens are from the nodules of Mazon Creek. Found also by Prof. A. H. Worthen, under the subconglomerate coal of Mercer co. Some obscure specimens from Newport, R. I., are less positively identified with this species.

SPHENOPTERIS (PROPER).

SPHENOPTERIS GRAVENHORSTII, *Brgt.*

Hist. d. veg. foss., p. 191, Pl. LV. f. 3. Lesqx. Geol. of Penn'a 1858, p. 861. Schp. Paleont. Veget., 1, p. 378.

Leaf tripinnatifid; rachis flat, smooth; pinnæ long, sublinear or gradually narrower to the apex, curved or flexous, alternate; pinnules (tertiary pinnæ) oblique, sessile, pinnately lobed; lobes cut to near the rachis, joined by the decurring base, the lower more deeply three or four toothed, the upper ones gradually more obscurely and less divided; medial nerve forking two to four times; veinlets forked again in the lower divisions, simple in the upper ones.

I have seen a number of specimens more or less obscure, eferable to this species, mostly from the coal of Rhode Island. These are deformed by expansion of some of their parts, and have the veins generally obsolete. The lobes are quite distinct as described and figured by the author, but their subdivisions or teeth are generally more or less effaced. A finer specimen from Clinton, is distinct in all its parts. The pinnæ are very long, eleven centimeters or more, with a flat broad naked flexuous rachis; pinnules short, the lower two centimeters, less deeply divided, joined by a broader decurring base with teeth also more obtuse. This specimen has a remarkable appearance; half of it, especially the lower part of the pinnæ has the epidermis totally destroyed by maceration, the veins however distinctly preserved, so that the pinnules appear as mere bundles of veins and vinelets, exactly as in Brongniart's f. 2 of the same plate, l. c., described as *S. myriophyllum.* The author rightly remarks that it represents merely the skeleton of a frond, whose pinnules have been deprived of epidermis by maceration. Our specimen shows the characters of both species in full evidence on the same pinna.

Habitat—Newport, Rhode Island. There is from this locality a good large specimen in the Cabinet of Amherst College. It has been figured, but omitted from want of place. Found also in the shale of the coal of Clinton, Mo., by Dr. J. H. Britts. Rare.

SPHENOPTERIS DUBUISSONIS, *Brgt.*

Hist. d. veg. foss., p. 195, Pl. LIV, f. 4. Lesqx., Geol. of Penn'a, 1858, p. 861. Schp., Paleont. Veget., I, p. 378.

Leaf tripinnate; rachis broad, rigid; pinnæ short, lanceolate; pinnules oblong, lanceolate, pinnately lobed; lobes distinct to below the middle, wedge form, obscurely tridentate; lateral veins tripartite.

This species, of which I have seen only one specimen, seems like a diminutive representation of the former. The rachis and its divisions are quite as thick, even stronger; but the pinnæ and pinnules are much shorter as also the teeth, mostly generally obscure. This specimen is fragmentary and may represent the same species as the former.

Habitat—Clinton, Mo. Dr. J. H. Britts, No. 145 of his collection.

SPHENOPTERIS MIXTA, *Schp., Pl. LIV, Figs. 1–3a.*

Schp. Paleont. Veget., I, p. 382. Lesqx., Geol. Rept. of Ill., IV, p. 409. Pl. XV, f. 7.

S. rigida, Lesqx., Ibid., II, p. 435, Pl. XXXIX, f. 5, 5a.

Frond large, tripinnate; primary and secondary rachis thick, rough; divisions linear-lanceolate and in right angle; secondary pinnæ with a very narrow flexuous rachis, pinnately divided; pinnules sublinear, obtuse regularly undulately pinnately lobed; primary veins inclined to the rachis, not decurring, branching into each lobe; veinlets forking near the borders, the upper ones simple; texture rather membranaceous surface smooth or polished.

The great thickness of the primary and secondary rachis is striking, compared to the narrow winged rachis of the small secondary divisions. These, only five to six centimeters in the lower part, are very gradually shorter towards the apex of the pinnæ, which were apparently twice as long as the fragments figured, or forty to fifty centimeters long. The pinnules are also comparatively very small; the lowest, one centimeter long and only two to three millimeters broad, are joined by a decurring base bordering the flexuous rachis, deeply undulately and pinnately lobed, gradually shorter, trilobed and then entire, toward the obtuse terminal leaflet. In other parts of the fronds, the simple pinnæ are longer and deeply pinnately divided in round crenulate lobes, separated to near the rachis, as in f. 3 and 3*a*.

Habitat—Clinton, Mo. Also Morris, Ill., shale above coal.

SPHENOPTERIS GRACILIS, *Brgt.*

Hist. d. veg. foss., p. 197, Pl. LIV, f. 2. Lesqx., Geol. Rept. of Ill., IV, p. 408, Pl. XV, f. 3–6.

Frond bipinnate; rachis very slender and narrow; secondary divisions distant, parallel, curved upwards, somewhat flexous, narrowly lanceolate; pinnules distant and distinct, sessile upon the very narrow naked rachis, pinnately four to five lobed; upper lobes confluent, the *lower distinct to near the base, oblong or ovate, entire or irregularly bi or tri-dentate; lateral veins very thin, pinnately forking in simple branches.*

This plant somewhat differs from the figure in Brgt., l. c. by the more irregular teeth of the lobes and the form of the pinnules, a little more enlarged at the base and less deeply lobate. It agrees however well enough with the description. The essential character from which the specific name is taken, the very narrow slender rachis is still more marked upon the American specimens than in the representation of the European plant. In some of the pinnæ, the pinnules are narrow, and as seen in the enlarged f. 4, l. c., they become sometimes cut to near the rachis. This species like the former is extremely variable in the shape and subdivisions of the leaflets. The nervation, the shape of the pinnules, the narrow rachis without any trace of margin, separate them easily.

Habitat—Shale of Morris Coal, Ill.

SPHENOPTERIS BRITTSII, *Sp. nov., Pl. LV, Figs. 2–2b.*

Leaf large, rachis of medium size, rough or scaly; primary pinnæ alternate, open, close and parallel, linear or sublanceolate; rachis punctate, obscurely regularly striate when decorticated; secondary divisions either long, linear, obtuse, pinnately divided in long sublinear pinnules, cut into six to ten pairs of half round or truncate lobes, connate from the middle, tridentate, at the apex, or short, obscurely five lobed; medial veins of the pinnules pinnately forked; veinlets simple; epidermis thick, surface somewhat rough, sometimes irregularly dotted.

The specimen figured has been until lately the only one I knew of this species; its characters are not sufficiently definite From a number of others communicated later by the discoverer Dr. Britts, to whom this fine species is legitimately dedicated, the pinnæ present two different aspects according to their relative position. The large pinnæ have a primary rachis half a centimeter broad, punctulate, even with a few short scales, bearing alternate, slightly oblique branches, averaging six centimeters long, with a rigid rachis, two millimeters broad and alternate linear pinnules, one centimeter long, divided as described above. Other fragments have the pinnules ovate, decurring as seen f. 2, but twice as large, merely irregularly five lobed, as marked f. 2*a*, which though an enlarged representative of f. 2, is much like the natural size of some of the fragments. The venation varies according to the size of the pinnules and of their divisions, the medial vein being either curved down as in f. 2*b*, or, as in the large pinnæ with multiple short lobes, where it is in right angle and merely divided into three branches. Compared to *S. mixta*, the relation of both species is easily remarked; the facies is about the same, but in the pinnately lobed leaflets of *S. Brittsii*, the lobes are distinctly tridentate at the apex. Even towards the upper parts of the pinnæ, the lamina becomes more deeply cut along the veinlets, and the lobes appear as if palmately divided, much like those of *S. tridactylites*, the subdivision being however more irregular and merely casual. Besides this the texture of the epidermis is coarser, the veins and veinlets thick, the rachis, even of the smallest divisions, rigid, never flexuous, etc.

I refer to this species, from similarity of characters in the broad rough rachis, in the shape of the fronds and of its divisions, a fructified specimen, with pinnules marked upon the medial veins by large round sori, one millimeter in diameter, nearly covering the surface of the lobes. As they are attached to the lower face, their outline only is distinct on the upper. One of the sporanges only discovered by abrasion, appears as formed of a central mammilla, from which nine narrow rays pass star-like to the circumference. Others less distinct have on the borders very small, globular, apparently loosened sporanges.

Habitat—Clinton, Mo., Dr. J. H. Britts.

SPHENOPTERIS PAUPERCULA, *Lesqx.*

Geol. Rept. of Ill., II, p. 435, Pl. XLI, f. 4, 4a. Schp. Paleont. Veget., I, p. 380.

Leaf bipinnate; pinnules open, distant, oblong, obtuse, *slightly narrowed at the subdecurring base; borders pinnately regularly undulate-crenate; primary veins distinct to the apex, pinnately branching, lower veins quadripartite, the upper ones forked, somewhat flexuous.*

The rachis is remarkably large (two millimeters), compared to the size of the pinnules, the lower ones only one centimeter long and half as broad, gradually smaller towards the apex, all equally distant, three millimeters. The pinnules, in form and size, are about like those of the large pinnæ of Pl. LIV, with borders less deeply lobed. This species is insufficiently known.

Habitat—St. John, Perry Co., Ill. A few other still more fragmentary specimens have been found in the anthracite of Pa., upper beds, near Port Carbon.

SPHENOPTERIS SCABERRIMA, *Lesqx.*

Geol. Rept. of Ill., IV, p. 408, Pl. XV, f. 1, 2.

Frond tripinnate; rachis thick in all its divisions; primary pinnæ lanceolate, long, curved downward from the main rachis; secondary divisions short, in right angle; pinnules connate at the enlarged base, lanceolate, more or less obtusely acuminate, with borders irregularly crenate by compression of marginal sori or tubercles (base of scales); surface of the whole plant very scabre.

The primary rachis, half a centimeter broad, is regularly distantly striate or ribbed, but like all the other parts of the plant, its thick cortex is covered with verrucose dots, evidently points of insertion of scales or hairs, which covered this Fern, and which are still distinctly seen on some fragments of the secondary rachis. The primary pinnæ, fifteen centimeters long or more (the upper part being destroyed), bear alternate, distant, comparatively short, linear-lanceolate secondary divisions, the lower, three centimeters long, gradually shorter toward the apex, all with thick rachis one millimeter at base, and small pinnules in right angle, averaging three millimeters long, and half as broad. The exact shape of these leaflets is not quite distinct; they are lanceolate, but the borders are deformed by compression and the flattening of dots or sori placed on the lower surface, and they appear, therefore, irregularly crenulate. No trace of venation is observable.

I compared this species, l. c., to a *Cheilanthes*, and indeed the irregular borders of the pinnules appear as if groups of sori were irregularly distributed under them, and covered by recurved lobules of the margins, as are the fructifications of this genus.

Habitat—Roof shale of the coal of Morris—very rare.

SPHENOPTERIS MICROCARPA, *Sp. nov.*, *Pl. XLVII, Figs. 2—2b.*

Frond quadripinnatified; rachis in all its divisions flexuous and winged; primary and secondary pinnæ in right angle, short, lanceolate, distant; pinnules oblong or lanceolate, narrowed at base, pinnately lobed; lobes distinct to the middle, ovate, blunt or acute, the lower ones slightly dentate; medial nerve flexuous, pinnately forked; lateral veins tripartite from above the middle or forked; sori very small at the end of some of the branch-veins, in the teeth of the border.

The fragment of this Fern, upon the same specimen as f. 1, of the same plate, may represent the upper part of a frond of large size. The primary pinnæ become rapidly shorter toward the apex; the secondary divisions, with about the same shape, and also as remarkably distinct, follow the same degree of decrease. They are subdivided into four pairs of pinnules only; the basilar, half a centimeter long, are distinctly lobate, while the upper are merely simple and connate to the terminal one. Each of the small obtuse teeth or indentations on the borders of the lobes has, at the top of one or two of the veinlets, small round elevated dots, which, seen with a glass, appear like sori. I consider them as fructifications, comparable, by their position at least, to the fruit dots of some *Davalliæ* of our time—*Leucostega*, for example.

Habitat—Helena coal mines, Ala.

SPHENOPTERIS (*Hymenophyllites.*)

Fronds polypinnate; axis of the ultimate and penultimate divisions composed of a narrow linear fascicle of veins, mostly united into a simple, rarely double nerve, bordered by a linear narrow lamina, repeatedly dichotomous; lobes entire, linear, obtuse or narrowly lancolate, acumenate, rarely cuneiform.

This group, very distinct in some of its species, is, however, so intimately allied by others to *Sphenopteris* that it is scarcely possible to limitate it exactly into a separate genus.

SPHENOPTERIS (HYMEN.) SPINOSA, *Goepp.*

Gatt., III, IV, p. 70, Pl. XII, f. 1.

Hymenophyllites spinosus, Lesqx., Geol. Rept. of Ill., II, p. 436, Pl. XXXIV, f. 3, 3a. Scph., Paleont., Veget., I, p. 405.

Frond devaricate-polypinnate; primary pinnæ reflexed, large; secondary divisions ovate or broadly lanceolate in outline, pinnately lobed; lobes pinnately or palmately cut in linear or wedge-form, obtuse, generally bifid laciniæ; surface squamose; veins buried into the epidermis, very thin, double, following the subdivisions to the apex.

This Fern receives its specific name from the peculiar shape of the terminal lobes of the pinnules, which are often simple, long, linear, obtusely acuminate. These lobes of a peculiar form are not spines, but mere elongations of the lamina, which is flat, inflated in the middle by fascicles of veins which divide, as in the other species of this group. As said above, the veins are buried into the squamose epidermis, but become observable, even distinct, when the surface is humected, the substance being membranaceous. The average length of the pinnules is two centimeters; the axis or rachis is two millimeters broad same width as that of the lobes.

Habitat—It is extremely rare in the American coal measures. Found until now only at Colchester, Ill.

SPHENOPTERIS (HYMEN.) SPLENDENS. *Lesqx. Pl. LVI, Figs. 4, 4a.*

Hymenophyllites splendens, Lesqx. Geol. Rept. of Ill., IV, p. 413, Pl. XIX, f. 2a, 2b.

Frond large divaricate; pinnæ in right angle, lanceolate; pinnules confluent to the alate rachis, pinnately or palmately lobed; lobes short, cuneiform, two or three dentate; teeth large, acute, entered by veinlets.

This species, in its essential divisions and its facies, has a likeness to the former. It differs, by the smooth shining surface, the shorter teeth of the lobes, none of them prolonged into a linear point. The lobes are indifferently, either pinnately or palmately lobed, upon the same pinnæ. The veins are very thin, divided from a double facicle, already at the base of the pinnules, and curving, either simple or dividing again, in passing out to the points of the lobes. F. 4*a*, enlarged, erroneously marked 4 upon the plate, clearly elucidates the mode of subdivision of the fascicle of veins, in passing to the point of the lobes or teeth, in all the species of the group. The epidermis of this species is easily detached in pellucid lamellæ, whereupon the venation is easily studied. This epidermis is generally of a reddish color. However, I have specimens from Clinton which are black colored, with a dull surface.

Habitat—Common in the coal shale of Colchester and Morris, Ill. Also found at Clinton, Mo.

SPHENOPTERIS (HYMEN.) FURCATA, *Brgt.*

Hist. d. veg. foss., p. 179, Pl. XLIX, f. 4, 5.

Hymenophyllites furcatus, Goepp., Syst., p. 259. Gein., Verst., p. 17, Pl. XXIV, f. 8–13. Schp., Paleont. Veget., I, p. 406. Lesqx., Geol. Rept. of Ill., IV, p. 470.

Sphenopteris flexuosa, Gutb., Abdr., p. 33, Pl. IV, f, 3.

S. alata, ibid., p. 34, Pl. V, f. 16, 17.

S. membranacea, ibid., p. 35., Pl. XI, f. 2.

Frond bipinnate; rachis flexuous, subgeniculate, concave on the upper surface, carinate on the lower, alate; pinnæ in right angle from the bents of the rachis; pinnules oblique, pinnately or palmately deeply lobed, wedge *form, deeply subdivided in two or three linear-lanceolate laciniæ, blunt at the apex, oblique or diverging.*

This species, rare in the American coal measures, could be compared to the former in representing it with all its divisions narrow, linear, cut to the base of the pinnules. The basilar pinnules, one and a half centimeters long, are generally palmately lobed from near the base, the lobes about half as long, are more or less deeply cut into linear laciniæ, simple or deeply bifid, either slightly enlarged in the middle, or linear-lanceolate, obtusely pointed or acuminate. The veins, as in the other species of this group, follow the subdivisions of the pinnules with simple branches ascending to the apex of the laciniæ. As indicated by the synonmy of this species, it is extremely variable, especially in the length and shape of the ultimate divisions of the pinnules.

Habitat—Merely found, until now, in the subconglomerate coal measures, opposite Mauch Chunk, Penn'a. I have seen also good specimens from the subconglomerate coal of Tennessee, in the cabinet of Prof. Jas. M. Safford.

SPHENOPTERIS (HYMEN.) HILDRETI, *Lesqx.*

Geol. of Penn'a, 1858, p. 863, Pl. IX, f. 5, 5a.

Leaf polypinnate; rachis narrow; pinnæ more or less oblique, pinnately divided; pinnules oblique, decurring to the winged rachis, ovate in outline, pinnately lobed; lobes cut to the base or to the middle in two to five linear acute laciniæ; primary nerves divided according to the subdivisions of the lobes, each entered by simple branches.

This species is much like the former, from which it differs by the rachis narrower, not geniculate, the pinnules all pinnately lobed, none palmately; the laciniæ shorter, more distinctly lanceolate-acute.

Habitat—Coal shale of the Kenawha, Salines, Kentucky. Communicated by Dr. Hildreth, of Marietta, Ohio.

SPHENOPTERIS (HYMEN.) FLEXICAULIS, *Lesqx.*

Hymenophyllites flexicaulis, Lesqx., Geol. Rept. of Ark's, II, p. 309, Pl. I, f. 1, 1a. Schp., Paleont. Veget., I, p. 409.

Frond pinnately dissected or repeatedly subdichotomous; primary rachis and all its divisions flexuous, winged; ultimate pinnæ divaricate, geniculate, pinnately divided; pinnules small, oval-oblong in outline, confluent to the rachis by the decurring base, palmately lobed; lobes short, entire, obtusely pointed, open; primary veins pinnately forking; veinlets simple.

A remarkable species, whose characters are difficult to fix, on account of the multiple divisions of the pinnæ which, interlaced together, cover the specimen with branches, branchlets, and pinnules, superposed in every direction, in a confused mass. All the branches diverge in an acute angle, as if dichotomous, with the subdivisions of the axis gradually narrower and flexuous. The ultimate pinnæ, about two centimeters long, have the narrow rachis distinctly and regularly geniculate or in zigzag, the pinnules fixed to the bent of the flexures, very small, three to four millimeters long, half as broad, all, even the terminal leaflets, equal and equally distant, three millimeters apart, ovate in outline, wedge form to the decurring base, pinnately or palmately cut in five linear slightly acute lobes joined in obtuse sinusses, disposed about like the fingers of a hand. The lateral simple veins ascend to the point of the lobes, as in the other species of this group.

Habitat—I found abundant specimens in the shale of the Males coal, on the middle fork of White river, Washington county, Arkansas, somewhat lower than the base of the Millstone grit. Not seen elsewhere.

SPHENOPTERIS (HYMEN.) TRIDACTYLITES, *Brgt., Pl. LV, Figs. 8, 8a, 9–9b.*

Brgt., Hist. d. veg. foss., p. 181, Pl. L. Gein., Verst., p. 15, Pl. XXIII, f. 13, 14. Schp., Paleont. Veget., I. p. 396.

S. quadridactylites, Gutb., Abdr., p. 36, Pl. XI, f. 5.

Hymenophyllites pinnatifidus, Lesqx., Geol. Rept. of Ill., II, p. 436, Pl. XXXIV, f. 2, 2a.

Frond tripinnate; primary and secondary rachis naked, *generally punctulate; pinnæ open; primary divisions lanceolate; pinnules equidistant, gradually shorter toward the apex, sessile and mostly perpendicular to the rachis, lanceolate in outline, pinnately lobed; lodes cuneiform, the lower trifid, the middle ones oblong, bifid, the upper simple; lacinæ more or less disjointed, linear-obtuse; veins once or twice forking, according to the divisions of the lobes; fructifications in round sori, irregularly grouped, generally covering the whole lower surface of the lobes.*

The fragments figured represent the characters of this species as they are more generally seen upon the American specimens. The lobes and their divisions are sometimes slightly longer or cut deeper into the lamina, as in the form described as *Hymenophyllites pinnatifidus*, Lesqx., l. c. which has also the upper lobes even the terminal ones bifid. From the European form, as described and figured by authors, the American plant differs by the primary and secondary rachis generally punctulate. The points are scattered, but easily seen with an enlarging glass, as well upon the cortex of the rachis as upon the surface deprived of it. The tertiary rachis are generally without a border; in the upper part only, the pinnules are somewhat decurring at the base and the rachis is bordered by a narrow membrane. The sori are quite distinct; but their position in regard to the veins is not ascertainable, as they cover generally in flakes the lower surface of the leaflets whose lamina is mostly invisible, as seen on the pinnule f. 9*a*, right side. When part of the lamina is preserved the scattering of the sori is local, either in the middle or on one side of the lobes.

The only affinity I can find between this species and living Ferns, in considering the mode of fructification, is in the *Grammittaceæ*, *Gymnogramma Calomelanos*, Kaulf., for example, an affinity in opposition to the other characters of the Ferns of this tribe. Per contra, the *Cheilanthæ* and the *Hymenophylleæ* to which this plant is related by its nervation and the mode of division of the pinnæ, cannot be compared to it by their fructifications.

Habitat—From the subcarboniferous measures, to the first coal above the Millstone-grit. A splendid specimen sent by Prof. E. T. Cox is from the Whetstone quarries of Indiana, horizon of the Chester limestone. The secondary pinnæ are twenty-four centimeters long, the pinnules oblong-obtuse, trilobate on each side, the rachis smooth, thus corresponding to Brongniart's plant, but with short laciniæ, and the tertiary rachis winged. Prof. A. H. Worthen has sent specimens from the coal No. 1, in Mercer county, Ill., subconglomerate. The specimen figured is from Clinton, communicated by Dr. J. H. Britts. I have seen some fragments also from the shale of Morris, Ill.

SPHENOPTERIS (HYMEN.) TRICHOMANOIDES, *Brgt.*

Hist. d. veg. foss., p. 182, Pl. XLVIII, f. 3. Schp., Paleont. Veget., I, p. 404, Pl. XXX, f. 3.

Leaf tripinnatifid; rachis flexuous, canaliculate and alate; pinnæ long, distant, flexuous, curved down or pending; pinnules oblique, pinnately lobed; lobes deeply cut, bifid, trifid or quadrifid; laciniæ diverging, linear, obtuse, each entered by a single branch of the veins.

This species is comparable to the former, differing by the lobes more divided, the laciniæ longer, narrower, and more diverging. It is easily recognizable by its yellowish membranaceous thin substance, often destroyed by maceration, so that in some specimens the black veins and their branches only are discernible. The American form has the laciniæ generally shorter than figured by Brongniart, more resembling the following.

Habitat—Morris, Ill. Helena vein, Ala.—rare.

SPHENOPTERIS (HYMEN.) QUERCIFOLIA, *Goepp.*

Syst., p. 252, Pl. XIV, f. 1, 2. Schp., Paleont. Veget., III, p. 403. Oligocarpia quercifolia, Stur. Culm. fl., p. 206, Pl. XV, f. 7–12.

Frond large, tripinnate; primary pinnæ lanceolate, the upper ones short, oblique, oblong-lanceolate; the lower much longer, curved down, linear; secondary pinnæ short, lanceolate, rigid; pinnules in right angle, joined at the base by the narrow wing of the rachis, ovate, obtuse, pinnately more or less deeply lobed; lobed crenate or laciniate;

lateral vein in each lobe dichotomous. branches simple, passing up to the divisions of the border.

This Fern is like the former of a yellowish membranaceous texture, on which the veins appear distinctly in black when the surface is humected. It is extremely variable in the size and form of the divisions of its pinnules. The lobes are ovate, either nearly entire or crenulate, sometimes more deeply cut, either into short obtuse, or in long wedgeform sparingly dentate laciniæ, like the fragments represented f. 7 and 8 of Stur. l. c. Our specimens do not represent any like this; I have also not seen any with the pinnules as large as figured by Goeppert, l. c., which average four millimeters long and two and a half millimeters broad, while the largest seen upon American specimens are nearly entire, two and a half millimeters long and scarcely two millimeters broad. The primary and secondary rachis half round or keeled, have a thick polished epidermis.

Habitat—Helena mines, Ala. I have not seen any specimens from other localities. There they are not rare and mixed with those of the following species.

SPHENOPTERIS (HYMEN.) ELEGANS, *Brgt., Pl. LV, Figs. 6, 6a.*

Brgt., Hist. d. veg. foss., p. 172, Pl. LIII, f. 1, 2. Schp., Paleont. veget., I, p. 389.

Acrostichum Silesiacum, St. fl. d. Vorw., I, p. 29, Pl. XXIII, f. 2.

Cheilantites elegans, Goepp., Syst., p. 233, Pl. X, f. 1; XL, f. 1, 2.

Deplothmema elegans, Stur., Culm fl., p. 130, Pl. XIII, f. 5; Pl. XIV, f. 1-6.

Frond polypinnate, secondary and tertiary rachis alate, flexuous; pinnæ in right angle, narrowly lanceolate; pinnules round-ovate in outline, the lower pinnately lobed, the upper merely bi, trifid or simple, oblong, cuneate to the base, obtuse, mostly entire at the apex; veins buried into the epidermis, obsolete.

The species varies in the size of the pinnules, sometimes with a longer pedicel than in our figure; but the difference is not very marked. According to Goeppert, Schimper and Stur, the primary rachis is wrinkled across as in many subcarboniferous species.

Habitat—Helena coal mines. The specimens all fragmentary are in the State Cabinet of Alabama.

SPHENOPTERIS (HYMEN.) LARISCHII, *Stur*, *Pl. LV*, *Figs. 7, 7a.*

Calymmotheca Larischii, Stur, Culm. Fl., p. 168, Pl. X; XI, f. 1.

Tertiary pinnæ lanceolate, in right angle to the narrow flexuous margined rachis; pinnules slightly oblique, pedicelled, pinnately lobed; lobes short, linear, truncate or bifid; veins branching according to the divisions.

I have seen only the fragment figured, too small for satisfactory determination. By the short mostly simple, rarely trifid divisions of the lobes, its relation is more distinctly marked with *Diplothmema Mládeki*, of the same author, l. c., p. 145, Pl. XVIII, f. 1, which has however shorter, closer pinnules, more generally trifid than pinnate, and the rachis more rigid and not winged.

Habitat—Woodsworth seam of Helena, Ala., Mr. T. H. Aldrich.

SPHENOPTERIS (HYMEN.) HOENINGHAUSII, *Brgt.*, *Pl. LV*, *Figs. 5, 5a.*

Brgt., Hist. d. Veg. foss , p. 199, Pl. LII. Gein., Verst., p. 14, Pl. XXIII, f. 5-6. Andræ, Vorw. Pflanz., p. 13, Pl. IV, V. Schp., Paleont. Veget., I, p. 385, Pl. XXIX.

Frond large tri, quadripinnate; primary rachis or stipe very thick, covered with scales or with tubercles, scars of their base; primary pinnæ lanceolate; secondary divisions in right angle, close, opposite or alternate, linear-lanceolate, gradually acuminate; tertiary pinnæ also in right angle, linear, obtuse, the basilar ones a little longer, pinnately, regularly divided; pinnules half round, contracted at the base, connate by the margin of the rachis, trilobate; lobes broadly cuneiform, obtuse, entire; lateral veins entering the lobes, simple or forking.

The stipe or basilar rachis of this species is very thick, three centimeters or more, covered with scales or with rhomboidal oblong tubercles, scars of their points of attachment, similar to small narrow scars of *Lepidodendron*. The pinnæ are very large. Though I had for examination a considerable number of specimens, I have not seen any in its whole, only fragments measuring sometimes twenty centimeters across. The figured specimen is part of a secondary pinna, with long tertiary branches and pinnules more distant than they are generally; for in most of the specimens the secondary pinnæ are shorter, the close tertiary divisions averaging one centimeter long with eight pairs of close contiguous pinnules. It is difficult to exactly see the details of the subdivision of the pinnules and their venation, on account of the coriaceous substance of the leaflets, wherein the veins are buried and whose borders are always more or less curved under the convex surface. Prof. Stur, in his Culm flora, has described as *Calymmotheca Strangeri*, p. 151, and splendidly illustrated, Pl. VIII and IX, large fragments of a Fern which, considering its characters without taking into account the fructifications, seem to represent this species. I am unable to find any difference either between the American subcarboniferous form which I refer to *S. Hoeninghausi*, Brgt., or that represented by the French author, and *C. Strangeri*.

Among the large number of specimens all from the same locality sent for examination, I did not find any trace of the fructifications referred to this last species and figured in the Culm flora. They are sporanges with a long pedicelled indusium composed of six linear lanceolate valves, six to seven millimeters long, related by their shape and disposition in simple racemes to the fructifications of *Archæopteris*. In these specimens also, all the fragments are pinnately divided, none of them forking even in the upper part of the pinnæ. In his comparison with *S. Hoeninghausii*, Prof. Stur enumerates differences which may be very clear from his specimens, but which I am unable to discern from my own. He considers *S. Hoeninghausii* as a more recent form derived from *C. Strangeri*. Perhaps I do not know the true *S. Hoeninghausii*, for all the specimens from which the species is described here are from the subcarboniferous or subconglomerate measures. I have not seen any from the true coal measures of this continent.

Habitat—Helena Coal mines, Ala., there extremely abundant, Prof. Eug. A. Smith. Wetstone beds, Ind., Prof. E. T. Cox.

SPECIES OF UNCERTAIN RELATION.

SPHENOPTERIS BALLANTINI, *Andrews.*

Geol. Rept. of Ohio, Paleont., II, p. 422, Pl. XLIX, f. 1.

Frond pinnately dichotomous; pinnæ distant, alternate, oblique, with a thick rachis; pinnules numerous, small, simple, linear-obtuse or bi, trifid, with lobes diverging linear-lanceolate acuminate; veins thin, dichotomous, each division ascending to the apex of the lobes.

The species has no relation to any other of this group. The main rachis, three millimeters broad at the base of the fragment, is not much stronger than the branches, and is covered with leaves, also, especially in the upper part. The pinnæ, opposite or alternate, are in acute angle, like dichotomous divisions, somewhat thicker in the middle; the pinnules two to five millimeters long, are open, some of them simple, linear, obtuse; others divided into two or three lobes or laciniæ to half the length of the lamina, are slightly enlarged and decurring at base, and only one to two millimeters broad.

Habitat—Subconglomerate measures, Perry County, Ohio, Prof. E. B. Andrews.

SPHENOPTERIS LINEARIS, *Brgt.*

Hist. d. Veg. foss., p. 175, Pl. LIV, f. 1a and b.

Frond pinnately dichotomous; primary rachis thick; divisions decurrent, half round or convex, flexuous, longitudinally striate; primary pinnæ oblique, linear-lanceelate; secondary divisions sessile, the lower open, the upper erect, linear-obtuse in outline; pinnules four to six pairs, alternate, cuneiform to the decurring base, curved back, enlarged in the middle, three to five lobed; lobes wedge *form, truncate or obtuse; veins simple in entering the lobes, dichotomous, forking near the apex.*

This plant as described above from a large finely preserved specimen appears to be referable to Brongniart's species whose diagnosis is made from a mere fragment, the upper part of a primary pinna. Our specimen represents two different forms. The first, with primary pinnæ fourteen centimeters long, has its secondary divisions three centimeters long, the lower ones a little shorter, open, the upper gradually more oblique, with the pinnules broadly cuneiform, obtuse, seven to eight millimeters long, three to four millimetres broad in the middle, the lobes wedge-form and more diverging than in the figure of the French author. In this, the primary veins only are discernible. The reverse of the specimen represent the species with the same general characters, but with pinnules narrower, lobes deeply cut, much narrower and the veins quite distinct. The pinnules with their nervation resemble those of the fragment Atl., Pl. LIII, f. 4; even the lobes appearing sometimes denticulate at the apex; but the plant is only half as large in all its parts.

Habitat—Ætna mines, Tennessee, subcarboniferous measures; Collection of Prof. Jas. M. Safford.

SPHENOPTERIS FLACCIDA, *Crepin.*

Bull. Acad. Roy. of Belgium, August, 1874, p. 7, Pl. II, f. 1–5.

Rachis thick, flexuous, with decurring branches; ultimate pinnæ ovate-lanceolate in outline, pedicellate, pinnately divided; pinnules cuneiform, lobes short, obtuse, truncate or bifid; veins dichotomous.

Allied to the former species, this one differs by the narrower shorter lobes of the pinnules, less enlarged towards the apex, simple or bifid. The ramification is of the same type; the rachis is half round, striate, like twisted or passed through a draw-plate, flexuous and often wrinkled crosswise, forking, with branches decurring to the main rachis. In our specimen, the veins are distinctly marked, the veinlets close and more numerous than in the figure of the Belgian author. Both this and the former species are intermediate between *Sphenopteris* and *Eremopteris* or the *Hymenophyllites* and the *Adiantites*.

Habitat—In the Vespertine (No. 10 of the Penn'a Reports), Sideling tunnel, Huntingdon Co., Pa., Mr. W. C. Ashburner. A number of specimens especially stems with branches and pinnules are identifiable with Prof. Crepin's plant. This one was found in the Psammites of Condroz, together with *Archæopteris hibernica* and other subcarboniferous species.

SPHENOPTERIS PLICATA, *Lesqx.*

Geol. of Penn'a, p. 862, Pl. IX, f. 3.

Pinnæ linear, pinnately divided; pinnules connate in obtuse sinusses near the rachis, inclined upwards, oblong, obtuse, with borders undulate crenate; veins obsolete.

This species without relation to any other known to me, is made from two fragmentary specimens. As the venation is unknown, it cannot be more specially considered until better materials are procured.

Habitat—Old shaft behind New Philadelphia, Pa.

EREMOPTERIS, *Schp.*

Upper part of the fronds dichotomous; pinnæ open or oblique, irregularly pinnatifid; laciniæ long, obovate or wedge-form, the lower ones deeply cut.

Prof. Schimper who has separated this genus from *Sphenopteris* says that the plants which compose it have no analogy with any Ferns living now hence its name *εϑημος* isolated, without relation to others, and *Πτεϑις* a Fern.

EREMOPTERIS CRENULATA, *Lesqx., Pl. LIII, Figs. 1, 2.*

Geol. Rept. of Ala., 1876, p. 75.

Pinnæ open, the lower in right angle, oblong-lanceolate in outline, decurring to the winged rachis, pinnately laciniate; lower segments bi or trifid, the upper bifid, the terminal simple; laciniæ cuneiform, curving back, and crenulate at the apex.

The laciniæ seen with the glass appear distinctly crenulate or dentate, at the apex, as seen f. 2; without enlarging power, they appear merely crenulate. This and the broader more diverging basilar laciniæ separate this species from *E. artemisiæfolia.*

Habitat—Helena mines, Shelby County, Ala., Prof. Eug. A. Smith.

EREMOPTERIS FLEXUOSA *Lesqx., Pl. LIII, Fig. 3.*

Lesqx., Geol. Rept. of Ala., p. 75.

Rachis flexuous, geniculate, narrowly winged; pinnæ in right angle, oblong, truncate at the apex, deeply pinnately lobed; lobes broadly wedge-form, entire or merely undulate, the terminal truncate.

Differs from the former by the lobes less or scarcely laciniate, not dentate, nor crenulate.

Habitat—Same as the former species.

EREMOPTERIS DISSECTA, *Lesqx., Pl. LIII, Fig. 4.*

Geol. Rept. of Ala., l. c., p. 75.

Pinnæ oblique, the upper ones erect, the lower long, pinnately lobed; lobes laciniate, segments narrow, sharply bi, tridentate.

Closely related to the former. Its rachis is also narrowly winged, somewhat flexuous, the segments much narrower, not curved backwards, the veinlets pointing out into the teeth at the truncate apex.

Though in comparing the specimens, all fragmentary, as figured, the difference in the characters seem very marked, these three species may perhaps represent only branches of a same Fern.

Habitat—Same locality as the former.

EREMOPTERIS ARTEMISIÆFOLIA, *Brgt., Pl. LIII, Figs. 5, 5a, 6.*

Schp., Paleont. Veget., I, p. 416, Pl. XXX, f. 5. Lesqx., Geol. Rept. of Ala., l. c., p. 75.

Sphenopteris artemisiæfolia, Brgt., Hist. d. veg. foss., p. 176, Pl. XLVI

and XLVII. St., Fl. d. Vorw., I, p. 44, Pl. LIV, f. 1. Lesqx., Geol. of Penn'a, 1858, p. 863; Geol. Rept. of Ky., IV, p. 434.
S. erithmifolia, Ll. and Hutt, Foss. fl., I, Pl. XLVI.
S. stricta, St., l. c., p. 45, Pl. LVI, f. 3.

Frond large, dichotomous; pinnæ oblique, pinnately laciniate; lower segments large, deeply divided, lobes somewhat diverging, long, obtuse, narrowed downward or subcuneate, the upper ones oblanceolate, mostly simple.

As seen from the figures of Brongniart, l. c., the species varies considerably in the size of the lobes, sometimes narrow, as in our specimens, sometimes twice as broad, scarcely divided. *S. crithmifolia*, Ll. and Hutt., has the lobes still much narrower, nearly linear, club shaped, very entire. It seems to be a different species. The American form is always, as far as it is known, represented as we have it in the Atlas, from the best specimens seen as yet, though we have many fragments of mere simple pinnæ, from different localities. On the upper surface the veins immersed into the epidermis are rather obscurely defined.

Habitat—Helena mines, Ala. Hazlegreen coal, Morgan Co., Kentucky. Shale of Morris Coal, Ill., of Cannelton, and of the Hollenback mines of Wilkesbarre, Pa. Always rare.

EREMOPTERIS ELEGANS, *Ett., Pl. LIII, Figs. 7, 7a.*

Asplenites elegans, Ett., Fl. v. Strad., p. 15, Pl. III, f. 1–3; IV, f. 1–3.
Sphenopteris asplenites, Gein., Verst., p. 17, Pl. XXIV, f. 6.
Rhaeopteris elegans, Schp., Paleont. Veget., I, p. 482.

Rachis strong, canaliculate; pinnæ linear; pinnules oblique, oblong or rhomboidal, narrowed to the rachis and attached to its flattened border, deeply pinnately lobed; lobes curved outside, separated to below the middle, cuneate to the base, truncate or subcrenate at the top; veins dichotomous, diverging fan-like from the base.

If this species, as Schimper remarks it, has an affinity with the group *Asplenites* and is closely related to the *Archæopteris*, it is also intimately allied to *E. Artemisiæfolia*. My specimens are as good as any of those described and figured by European authors, and distinctly shows the top of the laciniæ obtusely crenulate, notched or split, and the veins as distant and as much curved as in the former species. They are not as rigid nor as straight and distinct as in the *Asplenites*. The difference from the former species is marked in the rachis, not winged in our specimens, flat and merely narrowly channeled ; in the mode of attachment of the pinnules by a narrow base slightly decurring to the borders of the rachis, and in the nearly equal lobes of the pinnules ; but taken altogether the species has with *Eremopteris* points of relation distinct enough to be allowed a place in this genus.

Habitat—One of the specimens of this fine species was discovered by Mr. I. H. Southwell in the lowest coal strata of Ill., near Port Byron, Subcarboniferous ; the other in the bituminous shale of Cannelton, Pa., by Mr. I. F. Mansfield.

EREMOPTERIS MISSOURIENSIS, *Sp. nov.*, *Pl. LIII, Figs. 8, 8a.*

Frond bipinnate ; pinnæ linear or oblong, narrowed at base ; pinnules oblique, decurring to the alate rachis, lanceolate, longest in the middle of the pinnæ, very small towards the base, pinnately lobed ; lobes cut to the middle, the lower bi, trifid, the upper ones entire ; divisions broadly linear or oblanceolate, notched at the apex ; veins thin, sharply marked, dichotomous from the base, straight or slightly curving in the diverging lobes.

A peculiar species of which I have seen only the fragment figured. The general characters are those of this genus, the veins only being more rigid, more sharply defined, close and slender. At the top of the laciniæ, as many as ten to twelve veinlets can be counted with the glass. The middle pinnules are about one and a half centimeters long, while those of the two basilar pairs are scarcely three millimeters long and as large, trilobate, thus representing on the same pinnæ *Eremopteris* and *Triphyllopteris*.

Habitat—The remarkable specimen comes from the coal of Clinton, Mo., communicated by Dr. J. H. Britts.

EREMOPTERIS (TRIPHYLLOPTERIS) MICROPHYLLA, *Sp. nov.*, *Pl. LII, Figs. 6, 7, 7a.*

Leaf tripinnate; primary rachis thick, wrinkled across, flat; pinnæ nearly in right angle; secondary rachis narrowly winged; pinnules five to six pairs, subopposite or alternate, joined to the rachis by a broad base, distant, trilobate; lobes nearly equal, enlarged upwards, entire, the upper ones truncate or irregularly notched; medial veins distinct at base, dichotomous and flabellate; branches curved to the borders, forking as in Neuropteris.

This species like the former seems rather referable to the genus *Triphyllopteris* of Schimper though it has the lobes more distinct. The rachis is transversely rugose as in some species of this Genus and of *Archæpteris;* the veins, of the same character, divided from the base, are very close, twice in number to what is marked f. *7a.*

A small specimen from Kentucky has the pinnæ decurring to the rachis, which is a little flexuous, but wrinkled across like that of the figure. These pinnæ are somewhat longer, the two lower pairs of pinnules trilobate, the upper ones entire, broadly ovate, abruptly contracted to a broad decurring pedicel, the veins dichotomous. The medial vein is marked upon the trilobate pinnules, but in those which more entire have no lobes, all the veins are dichotomous and diverging from the base. The veins are very close but sharply cut and quite distinct under a magnifier.

Habitat—Helena mines, Ala., Prof. Eug. A. Smith. Haddock cannel coal vein, Osley Co., Ky. (Subconglomerate.)

SPHENOPTERIS (EREMOPTERIS ?) MARGINATA, *Andrews.*

Geol. Rept. of Ohio, Paleont., II, p. 422, Pl. LII, f. 1, 2.

Leaf pinnately divided, dichotomous; primary rachis thick, flexuous, bordered in its lower part by a crenulate margin; divisions alternate, decurring, simple, with a strong medial nerve or narrow rachis, linear-lanceolate, pinnately cut to the middle of the lamina in alternate lanceolate obtuse or acuminate distant lobes turned upwards; veins all from the medial nerve or partial rachis, *equal, thin, parallel, dichotomous and straight, or more or less curved in passing to the borders.*

F. 1 of the plate, l. c., represents the species as described. F. 2 is a pinna with the lateral divisions impaired or corroded by maceration in such a way that the lamina cut into flexuous linear acute laciniæ, is thus irregularly fringed. The base of the specimen, f. 1, already present traces of the same kind of laceration. It may be a normal subdivision of the plant in its upper pinnæ, as f. 1 seems to represent a basilar branch or a subdivision of the short main rachis, which flat and grooved in the middle, is bordered by a peculiar crenate membrane, apparently inflated at the borders.

The relation of this species to *Eremopteris* is doubtful. The nervation is neuropterid, of the same type as in *Megalopteris*, as are also the subdivisions of the pinnæ in decurring lateral lobes. It could be described as a new genus following *Megalopteris*, from which it differs essentially by the lobate borders of the pinnules.

Habitat—Subconglomerate coal measures, Perry county, Ohio, Prof. E. B. Andrews.

ADIANTITES, *Brgt.*

Fronds large, bipinnate; pinnules oblique, simple or bi, trilobed, gradually narrowed to the point of attachment; veins dichotomous from the base, dividing fan-like, straight, thin, distinctly marked.

To this group I refer *Triphyllopteris*, Schp., and *Archæopteris*, Daws.

TRIPHYLLOPTERIS, *Schp.*

Lower pinnules subopposite, tripartite or trifoliate, the upper ones gradually simple, all narrowed or contracted to a flat slightly decurring pedicel; veins all equal, simple or dichotomous, diverging fan-like.

TRIPHYLLOPTERIS LESCURIANA, *Meek, Pl. L, Figs. 6–6c.*

Cyclopteris Lescuriana, Meek, Bull. Phil. Soc., Wash., 1875, Appendix, p. 16, Pl. II, f. 1a, b, c.

Frond bipinnate, rachis of medium size and flexuous, *rugose crosswise; pinnæ alternate, narrowly lanceolate, open, with a narrow slightly flexuous rachis; lower pinnules alternate, the inferior ones only subopposite, broadly wedge-form, narrowed to a short, oblique, flat, pedicel, slightly decurring to the rachis, deeply three, rarely four lobate; lobes cut to the middle or lower, narrowly cuneiform, the middle one distinctly longer, all lanceolate-acute, entire or rarely obscurely dentate; nervation of the genus.*

The beautiful representation of this fine species is reproduced from Prof. Meek's plate. The author remarks that the nervation is rather obscure, the nerves not very numerous, moderately diverging and apparently bifurcating. He says also in a foot note, that the upper side of the pinnules can be seen under a strong magnifier to be covered with numerous extremely minute crowded longitudinal striæ, apparently independent of the nervation, and which can be traced down to the narrowed base. This appearance is the same in some of the Ferns, which I have described as *Eremopteris* and also, though less distinctly seen, upon the leaves of species of *Archæopteris* when the epidermis is preserved. I have remarked it also on the upper surface of the leaflets of many Ferns of the coal. It seems caused by extremely thin wrinkles or folding of the tissue which do not affect in any way the venation. The rugosity is sometimes crosswise, like that observed upon the epidermis of species of *Cordaites.*

This Fern is still more intimately related to *Archæopteris* than the species described as *Eremopteris*, which all by the characters of the ramification, the veins, the narrowed base, etc., might be very reasonably included, as they have been by Brongniart, into a same generic division that of *Adiantites*, which would comprise, with few exceptions, subcarboniferous Ferns.

Habitat—Lewis tunnel, Allegheny Co., Virginia, at the inferior part of the subcarboniferous series, Prof. B. F. Meek.

ARCHÆOPTERIS, *Daws.*

Cyclopteris, Goepp.: Adiantites, Brgt.:
Nœggerathia, Lesqx.: Paleopteris, Schp.

The species of this genus have been indifferently and more generally described as *Cyclopteris* and *Adiantites*. In Geol. of Penn'a, 1858, I considered these plants as identical to *Nœggerathia*, St., from the great likeness of the divisions of the pinnæ, and from the similarity of venation. Schimper considering the insufficiency of denomination under which species of far different characters had been described and also the error of references of these plants, true Ferns, to an European species which though little known was supposed to be referable to Palms or *Cicadæ*, proposed for them the name *Palæopteris* in his Paleontologie vegetale. This name however being preoccupied by Geinitz, Dawson re-placed it by a synonym, *Archæopteris*, which is likely to stand now if new discoveries do not prove that *Nœggerathia*, as figured and described by Sternberg and after him by Goeppert, is a Fern according to the opinion of this last author who compared it to *Adianthum* and not a kind of *Cycas*, as Brongniart will have it. My own opinion on this subject is of no account, as I have not been able to see any European specimen of *Nœggerathia*, and know these plants merely by the descriptions and figures of the authors. Judging merely from these figures, the leaves of *Archæopteris* have as far as I can see the same characters as those indicated for the genus *Nœggerathia*, viz: leaves pinnate; pinnules cuneiform or obovate, sessile, open or erect, entire or splitting at the top; veins straight more or less diverging simple and dichotomous. This is the description of *Nœggerathia* by Schimper, Paleont. veget., II, p. 120. Goeppert in Gatt., V, VI, p. 107, adds to his description of the genus, which coincidates with the above, this remark: this genus has been until now of doubtful relation. It has been generally considered as referable to Palms; close examination of a specimen communicated by the author (Sternberg), leads me to suppose that it belongs to the Ferns and is related to *Cyclopteris*. The disposition of the veins is however sufficient to separate the genera. In *Cyclop-*

teris the veins, diverging from their point of origin in the lower part of the leaves, multiply by divisions, so that there is a marked difference in their thickness from the base to the borders, while in *Næggerathia*, they come out from the base, preserving the same thickness, being at first parallel but gradually diverging on account of the widening of the lamina and dichotomously divided in acute angle. To the above may be now compared the description of *Archæopteris* as given by Shimper, Paleont. Veget., 1, p. 475.

Frond bipinnate; pinnules obovate or ovate oblong, inequilateral, gradually narrowed to a short subdecurrent pedicel, very entire or more or less split on the borders; veins coming out of the rachis, repetito-dichotomous, nearly straight; veinlets numerous, thin; fertile pinnules placed in the middle of the pinnæ, much divided, bearing numerous fascicles of club-shaped capsules or spore cases, attached to an excurring medial nerve.

The species of this genus made until now from too fragmentary or from obscure specimens are much mixed and uncertain. They may be separated into two groups from the characters of the rachis.

§ 1. *Rachis striate lengthwise.*

ARCHÆOPTERIS OBLIQUA, *Lesqx.*

Næggerathia obliqua (Gœpp.), Lesqx., Geol. of Penn'a, 1858, p. 854.

Leaf bipinnate; pinnæ oblique; pinnules comparatively long, wedge-form, or gradually narrowed to the point of attachment, obliquely truncate at the apex; veins emerging from the base, dichotomous, distinct.

This species is separated from all the others by its long pinnules, four to five centimeters long, exactly cuneiform, or gradually and equally enlarging upwards from the base to the truncate apex which is obscurely crenulate. This last character is not distinct. The base of the pinnules is somewhat broad, slightly decurring.

I referred incorrectly this species, l. c., to *Næggerathia obliqua*, Goep., Gatt., V, VI, Pl. XII, f. 2, on account of the obliquely truncate top of the pinnules. Goeppert's species is a *Cordaites*, and has no relation to plants of this kind.

Habitat—Red shale of the Vespertine below Pottsville, where it was found by my friend E. Desor, in 1851. I have not seen, since that time, any other specimen of that character, and never had an opportunity of reëxamining those from which the species was described.

ARCHÆOPTERIS OBTUSA, *Lesqx., Pl. XLIX, Figs. 6, 7.*

Nœggerathia obtusa, Lesqx., Geol. of Penn'a, 1858, p. 854, Pl. 1, f. 11.

Primary pinna very large; divisions alternate, open or curving back from the narrow naked rachis; pinnules large, half round at the apex, contracted and narrowed to the decurring base; nervation of the genus.

F. 6 is copied from the Geol. of Penn'a, l. c. and from it my decription was made at that time. Later I received from Mr. H. A. Riley of Montrose, Pa., a sketch of part of a pinna of a very large size, the lateral divisions twenty centimeters long, open and curving back, with pinnules, the largest (not figured) six centimeters broad in the upper rounded part, with borders entire undulate or even lobed at the top, as seen f. 6, abruptly narrowed to a decurring base. The average width of the pinnules is about four centimeters. Though the specimen is a large slab thirty-three centimeters broad and as long, none of the pinnæ is preserved whole. All of the pinnules have exactly the same character as seen upon the first published fragment, f. 6. Part of the plant from Montrose is reproduced in Dana's Manual of Geology, f. 557*A*.

Prof. Dawson has figured under this same name in Geol. Surv. of Canada, Foss. Pl. of the Dev. and Silur., 1871, p. 46, Pl. XVI, f. 188, a fragment of two pinnæ with the rachis slightly flexuous and pinnules oval long pediceled, which seems referable to a different species. The figure represents the venation with a basilar medial nerve from which the veins are derived, or flabellate dichotomous form a central point, as in *Cyclopteris*, contrary to the character of *Archæopteris*, whose veins are all coming out from the base, straight, dichotomous and diverging by branches in proportion to the enlarging of the lamina. He also remarks, p. 8, that *A. obtusa* belongs to a group with clustered pinnules, a character which does not belong to the plant, no more than does the long pedicel of the leaflets of his species.

Habitat—Vespertine red shale, below Mauch Chunk. Catskill red shale, Montrose, Pa., Mr. Henry A. Riley.

ARCHÆOPTERIS MINOR, *Lesqx., Pl. XLIX, Fig. 5; Pl. L, Figs. 1–4.*

Noeggerathia minor, Lesqx., Geol. of Penn'a, 1858, p. 854, Pl. I, f. 10.

Pinnæ oblique, rigid, sublinear; pinnules opposite or alternate, obovate, narrowed to a short decurring pedicel, very variable in size, oblique or slightly recurved from the base; fructifications of the genus.

All the specimens represented Pl. L, f. 1–4, have been found in the same bank of shale with a number of others. The pinnules vary from three to twenty five millimeters in length, generally narrow, either distant as in f. 4, or close and contiguous as in f. 1. They are generally obtuse and entire at the top, but sometimes undulate even undulately lobed, as in f. 2 and 4. Except therefore the diminutive size of the pinnules positively narrower, especially at the top which is not broadly round, but merely obtuse, even narrowed from the middle to an obtuse apex as in f. 4, there is not a very marked difference between this and the former species. The undulations of the pinnules, Pl. XLIX, f. 6, are quite as distinctly seen in f. 4 of Pl. L. This last pinna might perhaps be considered as referable to another species; but comparing it to f. 2, the pinnules appear exactly of the same character, and between this to f. 3, on one side and to f. 1, on the other, there is a series of intermediate forms, in specimens not figured, which do not permit a doubt on the identity of all the fragments. On the same pinna the pinnules are more or less oblique, more or less enlarged at the top and more or less curved backwards from the point of attachment. The rachis is generally thick, smooth, irregularly striate lengthwise and without any separate pinnules attached to it. The fructifications are of the same type as those described in the diagnosis of the genus which was made by Schimper from specimens of *A. Hybernica.* The support of the capsules is not a medial nerve, but a pedicel, gradually narrower to the apex, where it slightly curves upward, while in the European species it is percurrent, prolonged beyond the capsules and flexuous. The capsules appear as figured, open, composed of three laciniæ or lobes which seem placed aside as in f. 3*a*, generally erect on the upper part of the pedicel, also sometimes pending from it. These lobes, divisions of an indusium or spore case, are generally pressed together in such a confused mass that it is not possible to see the exact mode of their attachment, either as valves of an opened indusium or as closed capsules. They are flat or somewhat concave on one side, convex and marked by an obscure line like a medial nerve on the other, oblong or linear, obtuse at both ends. F. 3 and 3*a*, enlarged, represent them as exactly as it has been possible to observe them upon a number of specimens. The pinnæ, some of which bear leaflets at base, are oblique and apparently long. They are all broken about in the middle, eight centimeters from the rachis.

To this species I refer *A. stricta*, Andrews, Ohio Geol. Rept., Paleont., II, p. 418, Pl. XLIX, f. 2, 2*a*, part of which is represented upon our Pl. XLIX, f. 8, 8*a*. The pinnæ are more open; the pinnules smaller, more distant and more distinctly curved back. But we have the top of a pinna with leaflets of the same size, and with the same characters, Atl., Pl. L, f. 1, on the reverse of the fructified specimen f. 3. The number of veinlets at the border of the pinnules is exactly the same, ten to twelve. Schimper identifies *A. minor* with *A. Roemerianna*, Goepp., from which it differs by the rachis striate lengthwise.

Habitat—Red shale below Mauch Chunk, a single fragment; Bluffs of the Susquehanna above Pittston, Pa., there abundant. The Cabinet of Mr. J. P. Rosecranz of this place has a very large number of specimens of this fine species. We obtained fruiting fragments in visiting the locality with him.

ARCHÆOPTERIS HALLIANA, *Goepp.*

Sphenopteris laxa, Hall., Geol. Rept. of New York, IV, p. 274, f. 127.

Cyclopteris Halliana, Goepp., Uebergsg. Fl , p. 145 and 498. Daws. Fl. of the Dev. Period, sixteen Ann. Geol. Rept. of New York, p. 117, f. 10. Devon. plants, Quat. Jour. Geol. Soc , XVIII, p. 318, Pl. XVII, f. 54, 55. Devon. Plants of Maine, Nov., 1863, p. 469, Pl. XIX, f. 28.

Cyclopteris Jacksoni? Daws., Sixteen Ann. Rept., l. c., p. 115, f. 9. Devon. plants of Maine, etc., 1863, p. 462, Pl. XIX, f. 26. Geol. Surv. of Canada, 1871, p. 45, Pl. XV, f. 167–169.

Sphenopteris Hitchcockiana, Daws., ibid., p. 52, Pl. XV, f. 175.

Frond bipinnate; pinnæ alternate, sublinear, equidistant, open; pinnules alternate, open, oblong or spathulate, narrowed to a short petiole, entire; rachis alate by interposition of simple pinnules between the pinnæ; veins emerging from the base, simple or dichotomous.

As far as I can judge from the figure given of the species in the Sixteenth Ann. Rept. of New York, l. c., the pinnules are remarkably different in size, becoming larger towards the end of the lateral pinnæ, and along the main rachis between the pinnæ. It may be however that the interposed pinnules are partly buried into the stone, and show merely fragments of their laminas.

Schimper refers with doubt to this species *Cyclopteris Jacksoni*, Daws., l. c. As I have not seen any specimen of these two forms I am unable to decide. From appearance of the figures, the characters are identical. The same author quotes *Sphenopteris Hitchcockiana*, Daws., l. c., as a fruiting pinna of *A. Halliana* That this figure represents the fructification of a species of *Archæopteris* is positive, and Prof. Dawson has already recognized the accuracy of this reference; but in the absence of sterile leaflets, it is not possible to say to what species the fragment is referable. A figure of the same kind, indeed very similar to that of *S. Hitchcockiana*, is given in Prof. Crepin, Bull. Acad. Roy. d. Belgique, Aout., 1874, p. 5. Pl. I, f. 1, under the name of *Psilophytum Condrusorum.* It differs from that of Prof. Dawson merely in the acute lobes of the spore, cases. And even this difference could not serve as a specific diagnosis; for those capsules of *Archæopteris* are generally mixed and flattened in such a way that it is scarcely possible to satisfactorily define their form and position even with a powerful glass.

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*Palæopteris Haliana. Schp , Paleont. Veget , I. p. 477.

The only relation of the fructifications of any Ferns remarked until now with those of *Archæopteris* is with the genus *Calymmotheca* of Stur, as represented in *C. Strangeri*, Culm. fl., Pl. VIII, f. 7.*

Habitat—Devonian measures of New York, Hall, for *A. Halliana*. The specimen of *A. Jacksoni*, and *A. Hitchcockiana*, are from the Upper Devonian of Maine, Perry County, and the Lower Devonian of New York.

ARCHÆOPTERIS HYBERNICA ? *Ed. Forbes, Pl. L, Fig. 5.*

Cycloypteris hybernica, Ed. Forbes, Proc. Brit. Assoc., 1852. Goepp. Uebergsg. Fl., p. 499, Pl. XXXVIII, f. 1a, b.

C. McCoyana, Goepp. (fide Schp.), ibid., p. 500, Pl. XXXVIII, 2a, b.

Palæopteris Hybernica, Schp., Paleont. veget. I, p. 475, Pl. XXXVI.

Frond very large; pinnæ long; pinnules close, subimbricate, obovate decurring to the rachis by a short pedicel entire or undulate-crenate; rachis winged by intermediate pinnules attached to it.

I have a single leaflet which appears referable to the species by its undulate borders and its broadly obovate shape. This pinnule comes from a different locality than the specimens of *A. minor* but of the same geological horizon. Comparing it to f. 2*b*, of the splendid plate illustrating this species in Schp., Paleont. Veget., l. c., the likeness is well marked indeed. The pinnule is not unequilateral as are generally those of *A. hybernica;* but in many of these as in f. 2*b*, l. c., for example, the leaflets are equal on both sides similar to the one we have figured.

The leaflet, Atl., f. 5, though somewhat smaller has also the same characters and facies as the one figured by Daws, Quat. Jour. Geol. Soc., v. XVII, Pl. XII, f. 8, and described p. 273, as *Noeggerathia Gibboensis* from the Chemung of N. Y. I consider it referable to this species.

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*Schimper in a new work not yet out of the press, Handbuck der Paleontologie, prepared in coöperation with Karl A. Zittle, figures in the botanical part, p. 114, the fructification of *Triphyllopteris Collombi*, which show a close affinity to those of *Archæopteris*. They represent very small globular sporanges, disposed in racemes, like bunches of grapes.

Habitat.—Red shale of the Vespertine, near Pittston, Pa., Mr. James P. Rosencrantz.

ARCHÆOPTERIS BOCKSCHIANA? *Goepp., Pl. XLIX, Figs. 1–4.*

Adiantites Bockschii Goepp., Syst., p. 384, Pl. XXXVI, f. 6.
Cyclopteris Bockschii, Goepp., Uebergsg. Fl., p. 501, Pl. XXXVIII, f. 3.
Noeggerathia Bockschiana, Lesqx., Geol. of Penn'a, 1858, p. 854, Pl. III, f. 1–1d.

Bipinnate; pinnæ short, oblique; pinnules variable in form and size, generally oblique, small, reniform or broadly obovate, entire, short pedicellate, the terminal larger, broad, obtuse at the apex, contracted or gradually narrowed to its base a prolongation of the rachis, undulate or splitting in the upper part; veins straight, dichotomous, and diverging fan-like.

The fragments figured give an idea of the general character of the Fern. The pinnæ are short, oblique or in right angle, mostly trifoliate as in f. 1, 3, the upper ones, f. 2, pinnately divided. The side leaflets of the pinnate branches are generally unequilateral, either transversely oval or kidney-shaped, very short-pediceled, five to seven millimeters long, one centimeter broad; those of the trifoliate pinnæ are much larger, broadly cuneiform and rounded at the apex, narrowed to a slightly longer pedicel, the terminal ones are larger, either undulate or split at the top.

Though the leaflets are far different in shape from those of all the other species known of this genus, they have positively the same characters of nervation, as also the mode of attachment of the pinnules. From the likeness merely in the shape of the terminal pinnules, f. 4, I referred this species to *Adiantites Bockschii*, Goepp., l. c. According to Prof. Schimper, this reference is very uncertain, as Goeppert's species is not well known and is represented only by a single leaflet.

Habitat—Vespertine strata opposite Mauch Chunk; also below Pottsville on the same formation, always found in small fragments.

§ 2. *Rachis wrinkled crosswise.*

ARCHÆOPTERIS ROGERSI, *Daws, Pl. XLIX, Figs. 9, 9a.*

Cyclopteris Rogersi, Daws, Quat. Journ., Geol. Soc., Nov., 1863, p. 463, Pl. XVII, f. 17 and 18; XIX, f. 27.

C. (Archæopteris) Alleghaniensis, Meek, Bull. Phil. Soc. of Wash., Dec. 1875, Appendix p. 18, Pl. I, f. 2a, b.

Primary pinnæ linear-lanceolate, with a comparatively strong transversely wrinkled rachis; lateral pinnæ in right angle, close, short, oblong, obtuse; pinnules obovate, narrowed towards the base and decurrent to the rachis; venation of the genus.

Part of the beautiful figure of Prof. Meeks' memoir, l. c., is reproduced upon our plate with the name applied to it by the author. It is however evident that his species *C. Alleghaniensis* is identical with that of Prof. Dawson *C. Rogersi*, and that therefore this last name should be preserved. In both the figures given by the Canadian Geologist and in that of Meek, the peculiar characters, larger base of the decurrent pinnules, and rachis wrinkled crosswise, are represented the same. They are also identical in *C. Roemeriana*, Goepp. Uebergsg. l. c., Fl., p. 491, Pl. XXXVII, f. 8*a* and 8*b*, which however has the pinnules longer and narrower. Notwithstanding this difference I believe that Prof. Dawson is right in considering his species as the American representative of *C. Roemeriana*. Curiously enough, this last species is regarded by Crepin as a mere *var. minor* of *A. Hybernica*, which has the rachis striate lengthwise and beset with pinnules intermediate to the pinnæ or winged.

Habitat.—Lowest series of the carboniferous measures. Red shale of Perry county, Maine, Prof. Hitchcock. Lewis tunnel, Alleghany county, Virginia, Prof. B. F. Meek.

FRAGMENTS OF FERNS OF UNCERTAIN ATTRIBUTION.

CREMATOPTERIS PENNSYLVANICA, *Lesqx.*

Geol. of Penn'a, p. 868, Pl. III, f. 5.

Rachis thick, cylindrical; pinnules short, narrowly oval or oblong-obtuse, sessile, scarcely narrowed at the base, without trace of veins.

The specimen is not in a good state of preservation. The so-called pinnules are like flakes of coaly matter, without very determined outline, and without appearance of veins. Schimper supposes that it is merely a young unfolding frond of *Neuropteris*. The species is too uncertain and cannot be preserved. It is merely mentioned for future comparison in case of discovery of better specimens.

Habitat—The shale bearing this branch and seen in the cabinet of Mr. W. D. Moore of Pittsburg, is from the base of the barren measures near that place. It is covered with marine shells and fragments of vegetable remains, *Calamites* and some Ferns, especially a *Sphenopteris*.

PACHYPTERIS GRACILLIMA, *Lesqx.*, *Pl. LXXV, Figs. 10, 10b.*

Geol. Rept. of Ill., IV, p. 419, Pl. XIX, f. 6–8.

Separate pinnæ linear, simply pinnate; pinnules opposite, erect or oblique, narrow, spathulate, obtuse, decurring or confluent at base; veins obsolete.

This plant is very small: its fragments strewn upon the stone in great number, mere simple pinnæ, are two to four centimeters long, with pinnules nearly erect, scarcely half a millimeter broad, three long, opposite, decurring and joined at the base, bordering the rachis by a narrow margin between the leaflets. They may have a middle nerve, but on account of the narrow lamina, the nerve is undiscernible. The attachment of the two lateral branches upon the middle of a longer one f. 10 is merely casual.

The genus *Pachypteris*, Brgt., is established by the author for Jurassic Ferns, with pinnules entire, coriaceous, narrowly oval, contracted at the base, not connate to the rachis, without nerves or with a medial nerve only. The American plant has these characters, differing from the two species of Brongniart by the narrowness of the pinnules. It is comparable also to *Dicksonia gracilis*, Heer, Fl. foss. Arct., V, p. 13, Pl. III, f. 8–14, whose pinnules are sometimes very narrow and the medial nerve undiscernible. The pinnules, however, are evidently connate to the rachis at their base, and not decurring into a border, a character at variance with that indicated by Brongniart for *Pachypteris* On the specimen from which this species is described, the base of the pinnules, continued along the rachis and on both sides of it, is often partly separated from it in its whole length, showing the non-confluence of the border to the rachis.

Living species of *Adenopteris*, *A. hymenophylloides* and *A. tamarisci*, Kaulf., have the pinnules shaped and disposed as in this fossil plant.

Habitat—Shale of the Morris coal, Ill., Mr. Jos. Even. Cannelton, Pa., Mr. I. F. Mansfield.

RHACOPHYLLUM, *Schp.*

Schizopteris, Auct. (*ex p.*). *Aphlebia, Presl.* (*ex p.*). *Hymenophyllites, Goepp.* (*ex p.*). *Pachyphyllum, Lesqx.*

Fronds either flabelliform, many times subdivided or pinnate, irregularly pinnatifid, bipinnatifid; rachis flat, often much dilated, scarcely thicker than the foliaceous lamina which is very variable in the size and the mode of its divisions; veins numerous, more or less indistinct, following the rachis in parallel bundles, dichotomous in the foliaceous divisions.

This diagnosis is that of Schimper, Paleont. veget., I, p. 684, modified for the characters of the nervation. In describing some species of this genus, Geol. of Penn'a, 1858, I proposed for it the new appellation of *Pachyphyllum*, though the genus was already encumbered by too many synonyms. But the word *Pachyphyllum* (thick leaves) implies a character which is not remarked in all the now numerous species referred to this group, and as the nervation for a number of them is that of *Hymenophyllites*, I thought advisable to admit in the Geol. Rept. of Ill. this generic name employed by Goeppert. *Hymenophyllites* however cannot be applied to vegetable remains which have not all between them an evident relation; for if most of them are typically allied to *Hymenophyllum*, others have, in the shape of their leaves, and in the nervation, an affinity to *Neuropteris*, while others still, differing from any plants of the carboniferous, have characters which seem to place them as intermediate be tween marine plants and Ferns.

Instead of increasing the synonymy by new generic subdivisions, I admit here Schimper's nomenclature, grouping the species in three subgenera, *Rhaeophyllum* (Neuropterids), *R.* (Hymenophyllites), *R.* (Fucoides).

Though the morphology of the plants referred to *Rhaeophyllum* may be quite as clear as that of the other Ferns of the coal, their nature and their role in the vegetation is uncertain. Some are evidently Ferns, related to *Hymenophyllites* as said above, and their general character is of the same type. Others are attached to stems of Ferns, apparently as parasites ; others seem to be derived from a kind of Thallus, or form rhizomatic tufts of leaves, of characters different from those of the divisions of the branches. Stur considers them as leaves of support (Stutz-blätter), while Grand 'Eury is disposed to admit some of them in the Gymnosperm, as related to the *Noeggerathiæ.* Indeed the fragments figured and described as *Lepidophyllum anomalum* Atl., Pl. LXXXIII and LXXXIV, closely related to the *Cordaites*, seem to represent the plant described by Brongniart as *Aphlebia anomala*, considered until now as pertaining to the group of *Rhaeophyllum.*

This subject like many others concerning the vegetation of the coal is still obscure and demands from the phitopaleontologists careful investigation.

RHACOPHYLLUM (NEUROPTERIDS).

Fronds entire in the lower part, lobed at the top or pinnately divided from the base; divisions entire, obtuse or diversely laeinate; veins distinct and distant, diehotomous, following the directions of the lobes; ultimate divisions simple, entering the points of the lacinæ as in species of Sphenopteris (*Hymenophyllites*).

RHACOPHYLLUM FLABELLATUM, *St. Pl. LVII, Fig. 1, 1a.*

Aphlebia flabellata, St., Fl. d. Vorw., II, p. 112.
Filicites crispus, Germ. and Kaulf., Abdr., p. 229, Pl. LVI, f. 6.
Fucoides dentatus, Gutb., Abdr., p. 14, Pl. I, f. 1, 2.
Rhacophyllum flabellatum, Schp., Paleont. Veget., I, p. 687, Pl. XLVIII, f. 8.

Frond entire and oblong in the lower part, rounded at the base, enlarged and diversely lobed in the upper part; lobes curved outward, diverging, narrowed to an acuminate apex.

The beautiful specimen figured here represents a much larger leaf of this species than any of those published by European authors. The upper border is unfortunately partly broken, but the mode of division by obtuse sinuses in narrow linear laciniæ, is clearly seen on the half detached lobe of the right side. Another slightly smaller specimen, in the cabinet of Mr. J. F. Miller of Richmond, Indiana, is eleven centimeters long, from the broken base to the top of the laciniæ, four centimeters broad, split or bilobed from the middle, enlarged and flabelliform upwards, deeply lobed around the borders, the lobes subdivided in short linear laciniæ, blunt at the apex, as in Schimper's figure, l. c., the laciniæ being only somewhat shorter. In the specimen figured by Schimper, the lamina is cut from near the subcordate base into three lobes, the lateral ones diverging. In all the species of this genus the subdivision of the lamina is extremely variable.

Habitat—Nodules of Mazon creek, Mr. S. S. Strong. Coal, of Mercer Co., Ill. (subcarboniferous)· specimen in the cabinet of Mr. Miller.

RHACOPHYLLUM TRUNCATUM, *sp. nov., Pl. L, Fig. 7.*

Leaf apparently large, flabellate in the upper part, and there divided in broad linear obtuse or truncate lobes; veins thin but distinct, dichotomous.

Of this species I have seen only the fragment figured. By the curve of the borders on the left side, the leaf appears to have been about of the same shape as the former, with the same kind of divisions in large segments, descending to the middle of the lamina, then subdivided above in linear, obtuse or truncate lobes of about the same width, six to eight millimeters broad. The substance of this leaf is membranaceous, the veins, scarcely perceivable when the epidermis is dry, becoming quite distinct when it is moistened.

Cyclopteris Brownii, Daws, Quat. Journ. Geol. Soc. Nov. 1863, p. 463. Pl. XVII, f. 6, seems referable to this species, or at least to this group. The mode of subdivision of the borders, the narrowing of the lamina to the base and the venation are of the same characters.

Prof. Dawson remarks, on a leaf from Pennsylvania, seen in the cabinet of Prof. Wm. Rogers, that it bears a strong resemblance to *Salisburia adiantifolia*, a likeness which, considering merely the outline of the leaves is marked also in this species, and still more of *R. flabellatum.* The coincidence of habitat tends to confirm the supposition concerning the reference of Prof. Dawson's species to this one.

Habitat—Red shale of the Vespertine on the bluffs of the Susquehanna River above Pittston, with *Archæopteris minor.* Mr. J. P. Rosencrantz. Specimens of *Cyclopteris Brownii* were found in the Devonian of Perry County, Maine, by Prof. C. H. Hitchcock.

RHACOPHYLLUM MEMBRANACEUM, *Sp. nov.*, *Pl. LVIII, Figs. 1, 2.*

Leaf large, pinnately divided; primary divisions linear at the decurring base, enlarged and subdivided in the upper part; ultimate laciniæ short, lanceolate, acuminate, entered by a simple branch of the dichotomous strong veins.

A beautiful species which is represented in three specimens, one of which f. 1, is the upper part of an apparently very large frond, the other mere fragments of secondary pinnæ. The leaf, as in the former species, appears as split to the middle; the lateral divisions oblique, eight to ten centimeters long, are sharply bi, trifurcate, or irregularly divided in long linear laciniæ, which are subdivided into shorter lobes, and then sharply cut in triangular acuminate teeth. The substance is membraneous, yellowish, the epidermis easily separated in flakes.

I do not know any species published until now from the coal measures, which might be compared to this. *Rhabdophyllum pachyrachis*, Schenk, figured by Heer, Fl. foss., Helv., Pl. XXVI, f. 5, resembles it only in the lateral divisions of the leaf, the nervation being of a different type, or the veins derived from a midrib.

Habitat—Clinton coal, Mo., communicated by Dr. J. H. Britts.

RHACOPHYLLUM SCOLOPENDRITES, *Lesqx.*

Scolopendrites grosse-dentatus, Lesqx., Geol. of Penn'a, 1858, p. 868, Pl. VIII, f. 7.

Fragment of a linear leaf, deeply, obtusely and irregulayly dentate on the borders; medial nerve thin, veins widely distant, alternately diverging in acute angle from the midrib, extremely thin, once or twice forked, slightly curving to the borders; substance of the leaves thin, membranaceous, pellucid.

I am now as uncertain on the relation of this fragment as when I described it, l. c.; for since that time I have never been able to find, either in fossil Ferns or in those of our time, any plant comparable to this one. The fragment, the best which could be preserved on account of the extreme brittleness of the shale, is seven centimeters long, two centimeters broad at the broken base, where the borders are merely undulate, three centimeters in the upper part, where the obtuse teeth, which in the middle are large and more distant, become closer and more effaced. The midrib, though thin, half a millimeter, is every distinct, and the lateral veins, averaging five millimeters in distance, are also distinct, though of extreme tenuity, not half as thick as the middle nerve, from which they diverge in an angle of about 10°. They are somewhat flexuous and generally fork twice in passing to the borders where they casually enter the teeth or the irregular subdivisions which are without relation to the venation. The affinity of this Fern to *Scolopendrium* is marked merely by the linear ribbon shape of the leaves.

Its reference to *Rhacophyllum* is presumable only, from the peculiar charater of the venation.

Habitat—Gate vein, New Philadelphia, Pa.

2. §. RHACOPHYLLUM. (HYMENOPHYLLITES.)

Fronds flat, diversely lobed, and laciniate, all the divisions dichotomous; veins in parallel fascicles, constituting the axis of the leaves, dividing in bundles in entering the subdivisions, sometimes dichotomous, generally obsolete.

The venation of the plants of this group is rarely distinct, except in some species of thick texture, when the epidermis is destroyed.

RHACOPHYLLUM ARBORESCENS, *Lesqx.*

Schp., Paleont. veget., III, p. 525.

Hymenophillytes arborescens, Lesqx., Geol. Rept. of Ill., IV, p. 415, Pl. XVII, f. 1.

Leaf large, linear in outline, with a broad flat axis, pinnately alternately dichotomous; divisions or pinnules oblique, pinnately lobed; lobes simple, bifid or trifid, veins obsolete.

The preserved part of the leaf is twenty centimeters long; the axis or rachis is linear, quite flat, like the primary divisions, one and a half centimeters broad. These are alternate, at irregular distance, subdecurrent, not narrowed at the base, pinnately irregularly lobed, the lobes bi, tridentate or entire, broadly lanceolate, acute or blunt. The terminal lobe of the pinnules is sometimes long and linear. The veins are not clearly defined, but are perceivable in parallel fascicles, either vertical in the primary axis or diverging and parallel also in the primary lateral branches. The species is closely related to *R. pachyrrachis* (*Schizopteris*), Schenk, of the Keuper.

The divisions of the plants of this group are generally produced by expansion and splitting of the laminæ and are therefore simply or many times dichotomous, the ultimate divisions being called lobes or teeth according to their shape.

Habitat—Morris, Ill.; roof shale of the coal, communicated by Mr. Jos. Even.

RHACOPHYLLUM LACTUCA, *Sternb.*

Schizopteris lactuca, Presl., in St., Fl. d. Vorw., II, p. 112. Gein., Verst., p. 19, Pl. XXVI, f. 1. Germ., Verst., p. 45, Pl. XVIII and XIX.

Fucoides crispus, Gutb., Abdr., p. 13, Pl. 1, f. 11.

Pachyphyllum lactuca, Lesqx., Geol. of Penn'a, 1858, p. 863, Pl. VIII, f. 4, 5.

Hymenophyllites lactuca, Lesqx., Geol. Rept. of Ills., IV, p. 415.

Rhacophyllum lactuca, Schp., Paleont. veget., I, p. 684, Pl. XLVI, f. 1; XLVII, f. 1, 2.

Frond large; medial axis or lamina either prolonged and pinnately divided, or sessile, enlarged from the base, fanlike, and laciniate all around; primary divisions large, curving outward, variously cut into large lobes; ultimate divisions short, linear-lanceolate or long, linear, flexuous, generally obtuse.

The leaves are most variable in their general outline and subdivisions. In large specimens from the Penn'a anthracite coal fields I have seen the primary fronds nearly round in outline or broadly ovate, sessile, with border divisions multiple and multifid. In others, the axis is prolonged into a broad linear flexuous lamina, diversely folded and diversely divided in large dichotomous pinnæ, curving down and subdivided in short laciniæ. F. 4, of Pl. VIII, in Geol. of Penn'a, l. c., represents a diminutive leaf of the first character, the figures of Germar, l. c., are a splendid representation of the other. The plants are generally found in fragments which may be recalled to the type by their flat thin substance, where no trace of veins is apparent, and whose borders are diversely cut, sometimes in long linear laciniæ, dichotomously and many times subdivided in segments, gradually narrower, the ultimate ones long, flexuous, sometimes split. It passes by transition to the following species and is easily confounded with it.

Habitat—In the whole thickness of the middle carboniferous measures, not rare, but rarely seen on account of the obscurity of its outline and divisions, which of thin substance, are immersed into the stone or scarcely distinguishable from it. Gate vein below New Philadelphia, Penn'a; Mazon Creek, Ill., in nodules; Shale of the Coal of Cannelton, Pa. and Clinton, Mo.

RHACOPHYLLUM FILICIFORME (*Gutb.*), *Schp.*

Fucoides filiciformis, Gutb., Abdr., p. 11, Pl. I, f. 3, 6, 7.
Schizopteris Gutbieriana, Gein., Verst., p. 19, Pl. XXV, f. 11–14 (fide Schimper).

Medial axis comparatively long and narrow, flat, erect, pinnately divided; primary pinnæ narrow, pinnately lobed; lobes subpinnato-laciniate; ultimate segments short, truncate or obtuse. In the var. Gutbieriana, the lateral branches are simply divided in short, obtuse, entire or crenulate lobes.

The above description is made from a specimen whose main axis is one centimeter broad, ten centimeters long, nearly as thick at the upper part, where it is effaced in dividing. It is pinnately divided from the base as described above, the divisions oblique and variable in length, the lower five centimeters, the upper ones seven to eight. It corresponds exactly in its characters, for the medial axis to f. 1, Pl. I, of Gutb., l. c., and for its divisions to f. 6.

Among a large number of specimens which I have had for examination, I have never seen a transitional form to f. 14 of Gutb. and f. 13 of Gein. which represents *R. Gutbierianum.* When seen with the glass the upper surface of the plant is apparently villous or marked with very small points indicating base of hairs.

The specimen described above represents, as coming out of the same basilar stump, a pinna or simple frond of Pecopteris, which seems either dwarfed or as yet not entirely developed. Its lateral pinnæ and pinnules are distinct but the nervation is totally obsolete. This specimen, with others described here below, confirm the supposition of Prof. Schimper that some species of this genus are primitive basilar leaves of Ferns appearing before the unfolding of the fronds.

Habitat—Nodules of Mazon Creek, Ill., there not rare. Clinton, Mo., upon coal shale. The var. *Gutbieriana* is also commonly found in the whole thickness of the Middle Coal Measures. It seems to be a distinct species.

RHACOPHYLLUM CORRALLUM, *Sp. nov.*, *Pl. LVII*, *Figs. 4, 4a.*

Basilar pinnæ diverging in circle from a central axis (or rachis), broadly lanceolate, pinnately dichotomous; divisions oblique; pinnules either entire, short, obtuse, truncate, or pinnately dichotomous; ultimate laciniæ narrow, simple or forked once or twice; surface dotted and hirsute.

As represented in the figure, the pinnæ, two to four centimeters long, are generally regularly pinnately divided into nearly entire obtuse truncate or bifid lobes which, in the lower part of the pinnæ, are subdivided into narrow linear small laciniæ, either simple or forking once or twice. Another specimen, recently received, represents the species with primary pinnæ surrounding the base of a naked flattened rachis? or stem, ten centimeters long, nine millimeters broad, gradually narrower to the point, which is broken. These pinnæ are somewhat longer than those figured; palmately laciniate at the base, with divisions multifid, while in the upper part the lobes are merely oblong, or lanceolate, obtuse, or truncate, thus showing the two kinds of divisions seen upon f. 4. The pinnæ are distinctly seen attached to the base of the naked rachis and flattened around it. Geinitz, Verst., Pl. XXI, f. 1, represents a Fern bearing upon the rachis, as parasite, tufts of leaves of a species which he refers to *R. Gutbierianum*. From this specimen as from others, like *R. adnascens*, it is seen that plants of this group were, in some cases at least, parasitic.

Habitat—Nodules of Mazon Creek in fine specimens.

RHACOPHYLLUM CORNUTUM, *Sp. nov.*, *Pl. LVII*, *Figs. 3, 3a.*

Leaf tripinnatifid; primary pinnæ long, oblique; secondary divisions short, linear-lanceolate, obtuse, pinnately lobed; lobes short, half round, with borders inflated;

veins thin, in fascicles, ascending into the lobes; surface rough.

The divisions of the plant are opposite or alternate; the primary rachis is flat, not inflated as incorrectly shown on the figure, comparatively broad; the veins, seen only where the epidermis is destroyed, are in parallel fascicles, diverging in passing into the divisions, not dichotomous. The leaves are more distinctly pinnate than in any other species of the genus. The lobes on the specimen, figured from a nodule, appear inflated on the upper border. On another specimen from Cannelton, they are all flat. The epidermis is thickly dotted, as from the remains of basilar points of hairs.

Habitat—Mazon Creek in nodules. Cannelton, Pa., on shale.

RHACOPHYLLUM HIRSUTUM, *Lesqx., Pl. LVII, Fig. 2.*

Schp., Paleont. veget., II, p. 687.
Pachyphyllum hirsutum, Lesqx., Geol. of Penn'a, p. 863, Pl. VIII, f. 3.
P. affine, Lesqx., ibid., Pl. VIII, f. 1.

Primary rachis or lamina broad, flexuous, bipinnately dichotomous; pinnæ oblique, either pinnately divided into short, triangular, entire, obtusely pointed lobes, or cut in irregular linear-lanceolate acuminate laciniæ; surface covered with long distinct hairs or scales; veins in parallel fascicles.

The divisions of the axis or lamina are extremely variable. In the specimen figured Geol. of Penn'a, l. c., the pinnæ are simply lobed, the lobes short, broadly lanceolate, entire. In the specimen figured here, the lobes are diversely and irregularly cut and the ultimate laciniæ much narrower and distinctly acuminate.

Habitat—Salem Vein near Pottsville, Penn'a, upper Coal The specimen figured is from Clinton. Mo., r. J. H. Britts.

RHACOPHYLLUM FIMBRIATUM, *Lesqx.*

Pachyphyllum fimbriatum, Lesqx., Geol. of Penn'a, 1858, p. 863, Pl. VIII, Fig. 2.

Frond bipinnate; primary pinnæ linear, narrowed to the point of attachment; lobes lanceolate, entire, bordered *by a fimbriate membrane; veins in distinct fascicles, following the divisions of the lamina and passing up to the apex of the lobes; substance membranaceous.*

This species is much like the former and at first sight it could be taken for a variety caused by maceration of the plant and deprived of its epidermis. There is a marked difference, however, in the substance of the leaves which is rather membranaceous, not thick; in the peculiar narrowing of the pinnæ, contracted in joining the rachis; in the mode of attachment and nature of the border divisions which are not hairs, as in the former species, but true fringes, derived from the borders and enlarged in joining them as if they were cut from the substance of the leaves. In this species the nervation is distinctly seen as a narrow simple thick fascile of veins, in the middle of the primary rachis and of the divisions diverging and ascending to the apex of the lobes.

It is remarkable that both these species so very similar in some of their characters and so different in others were found together in two localities only.

R. affine, Lesqx., Geol. of Penn'a, l. c., is apparently a variety of this or of the former species. It is represented by a too small specimen, merely differing by the borders entire or deprived of a fringe · the venation is of the same type.

Habitat—With the former, Salem and Gate Vein, near Pottsville, upper Coal. Clinton, Mo., lower Coal, Dr. J. H. Britts.

RHACOPHYLLUM CLARKII, *Lesqx., Pl. LVII, Fig. 5.*

Hymenophyllites Clarkii, Lesqx., Geol. Rept. of Ill., II, p. 438, Pl. XXXIX, f. 7; IV, p. 416, Pl. XVI, f. 1, 2.

Frond large, with a distinct rachis of medium size, irregularly many times dichotomous; pinnæ reflexed, flabelliform, from a wedge shaped base; lobes oblanceolate, obtuse, veins in parallel fascicles, diverging in passing to the lobes, ultimate divisions simple.

This species is extremely variable in size. The fragment figured seems to be a primary young frond. It gives an idea of the mode of subdivision of the lobes only, but not of the plant in its entire development. The rachis in ascending is laterally divided either pinnately on both sides, or merely on one side, into flabellate pinnæ, enlarging by dichotomous subdivisions into lobes of various length, curved backward, cut in obtuse oblanceolate laciniæ. The epidermis is thick, rough, especially upon the rachis, often destroyed by maceration, and in this case only, leaving exposed the venation in parallel fascicles, dividing into each of the lobes, and apparently ascending in simple veinlets to the apex of the ultimate laciniæ.

This species has a great affinity to *R. Gutbierianum*, from which it differs by its distinct sometimes long rachis, the obtuse divisions of the pinnæ and the thick substance of the plant. In the nodules of Mazon Creek, where its remains are not rare, they leave upon the stone deep impressions, such as can be done only by thick bodies of hard consistence.

Habitat—Shales of Mount Hope Coal, Rhode Island, Mr. Jas. H. Clark. Nodules of Mazon Creek, frequent. Also found at Cannelton, but rare. Not seen in the specimens from Clinton, where *R. filiciforme* and its variety *R. Gutbierianum* are common.

RHACOPHYLLUM SPINOSUM, *Sp. nov., Pl. LVIII, Figs. 4, 5.*

Rachis flat, broad, pinnately dichotomous; pinnæ diverging in acute angle, lanceolate, pinnately lobed; lobes short, spinescent, simple or bi, trifid.

As seen from the fragment of a primary rachis at the base of the figure, we have a mere pinna of a plant which had apparently a large frond. The divisions are all of the same character, gradually passing into short ultimate laciniæ resembling spines, either simple or forked. The veins are clearly seen in parallel fasciles on the rachis, and may be followed into the lateral pinnæ, where they disappear, probably there dividing into very thin branches, and passing into the lobes. The rachis is distantly dotted. The points are indistinct on the decorticated surface, f. 5.

The stem and its ramification are more clearly defined than in *R. filiciforme* to which this species has some affinity; the lobes are shorter and sharply acuminate.

Habitat—Clinton, Mo., Dr. J. H. Britts. Mazon Creek, in nodules.

RHACOPHYLLUM HAMULOSUM, *Sp. nov. Pl. LVIII, Fig. 3.*

Frond divaricate or pinnately divided; ultimate pinnæ either lobed, the lobes deeply diversely lacinate, or simple in the upper part of the pinnæ; lacinæ linear, gradually narrowed to a long filiform more or less hooked acumen; venation obsolete.

This plant might perhaps be considered as a variety of the following species which is extremely variable. It essentially differs by its multiple divaricate ramification from a definite stem or primary rachis; by the absence of any trace of veins and the long acuminate apex of the lacinia.

Habitat—I have seen one specimen only, communicated by Dr. J. H. Britts, from the same locality as the former species.

RHACOPHYLLUM ADNASCENS, *Ll. and Hutt., Pl. LVII, Figs. 9, 10, 11.*

Schizopteris adnascens, Ll. and Hutt. Foss. fl., II, p. 57, Pl. C and CI. Gein., Verst., p. 20, Pl. XXV, f. 7–9.

Fucoides radians, Gutb., Verst., p. 12, Pl. I, f. 5.

Trichomanites adnascens, Goepp., Syst., p. 266.

Rhodea radians, Presl., in St. Fl. d. Vorw., II, p. 11.

Aphlebia adnascens, Presl., ibid.

Hymenophyllites adnascens, Lesqx., Geol. Rept. of Ill., IV, p. 414.

Rhacophyllum adnascens, Schp. Paleont. Veget., I. p. 686, Pl. XLVIII, f. 1, 2, (7?)

Frond small, many times dichotomous; divisions radiate or divaricate from the base, narrow, linear, obtuse; veins parallel or simple in each division, often obsolete.

This species is extremely variable, as far at least as it is known from fragments generally referred to it, or as seen by the three specimens figured. F. 9 has a distinct rachis with veins parallel, diverging in fasciles, dichotomous and passing in simple veinlets into the ultimate lobes. This form corresponds to f. 7 of Schp., l. c., which he considers as either referable to this species or perhaps representing a young plant of *R. flabellatum.* F. 11, in Atl., has the ordinary size and mode of division of the species, differing merely from f. 10 by a medial vein, which passes by veinlets to the apex of the lobes. F. 10 is the species as represented by the original authors Lindley and Hutton, who figured it in numerous specimens attached as parasite on the stem of *Sphenopteris crenata.* In this as in some similar cases where I have seen *R. Lactuca* and *R. filiciforme* in connection with rachis of Ferns, these plants seem to appear first as a primordial vegetation, a kind of prothallium, which continues growing upwards in connection with the rachis of the Ferns, even reaching the primary divisions of the fronds

Habitat—Generally found in fragments of its divers forms in the whole extent of the middle coal measures ; not rare, but rarely observed by collectors.

RHACOPHYLLUM TRICHOIDEUM, *Sp. nov.*

Pinnules rounded to the point of attachment, divided to the base in capilliform filaments diverging fanlike, forking once near the base or at a distance from it, then simple, flexuous in various directions, variable in length.

One of the specimens bears, seemingly attached along the borders of a leaf of *Cordaites*, three pinnules, five to six centimeters distant, appearing like bundles of veins deprived of epidermis. The base of these fasciles is four to five millimeters broad, the filaments cylindrical, capillaceous, four to five centimeters long, flexuous and flagellate in the upper part, of the same thickness in their whole length.

These filaments, as seen in the upper part where some of them are flattened, are not simple nerves but fasciles of very thin thread-like veins.

Habitat—Wilkesbarre, Pa. Specimens in the cabinet of Mr. R. D. Lacoe, from Oakwood colliery, F ? vein.

RHACOPHYLLUM INFLATUM, *Lesqx., Pl. LVII, Figs. 7–8.*

Hymenophyllites inflatus, Lesqx., Geol. Rept. of Ill., IV, p. 414, Pl. XVI, f. 6, 6a.

Frond small, pinnately divided; pinnæ deeply pinnately lobed; lower lobes bifid or quadrifid, with obovate divisions, the upper simple, oblong, obtuse; veins simple or dichotomous by branching into each lobe.

No other fragments of this species have been found than those figured. They seem at first sight to represent a *Sphenopteris*. But comparing them to f. 11, of the same plate, the relation between the two species is observable not only in the mode of venation, but also in the subdivisions of the pinnæ, the ultimate laciniæ being in both figures simple or bifid, obtuse, even somewhat broader at the apex.

This plant has also a marked affinity to *Hymenophyllum Weissii*, Schp., Paleont. veget., I, p. 415 Pl. XXVIII, f. 4–7, described by the author from specimens communicated by Prof. Weiss. The analogy of this *R. inflatum* both with *R. adnascens* and a species of *Hymenophyllum* sufficiently warrants the reference to *Hymenophyllites* of a number of the plants described under this new generic name.

Habitat—Roof Shale of the coal of Duquoin, Illinois.

RHACOPHYLLUM EXPANSUM, *Sp. nov., Pl. LVII, Fig. 6.*

Frond apparently large, with a rachis pinnately repeatedly dichotomous; rachis and divisions bordered by a large membranaceous lamina, without traces of veins, cut into broadly lanceolate acuminate lobes.

This very peculiar species is represented by a rachis twice pinnately divided, the divisions gradually shorter and narrower from the base to the apex, spiniform, lanceolate-acuminate, simple or forking again, a mode of division exactly similar to that of *R. spinosum*. The membrane bordering all the divisions and assimilated to their shape, linear along the main rachis, cut in lanceolate acuminate lobes corresponding with the sharply pointed branches of the pinnæ, is flat, smooth, membranaceous, without trace of veins. The peculiar conformation of texture of this plant does not find any point of comparison in the Ferns and therefore its relation is uncertain.

Habitat—Coal shale, Oliphant, Pa., specimen in Mr. R. D. Lacoe's cabinet.

RHACOPHYLLUM THALLIFORME, *Lesqx.*

Hymenophyllites thalliformis, Lesqx., Geol. Rept. of Ill., IV, p. 417, Pl. XVI, f. 3–5.

Leaf simple, apparently flattened upon the ground, undulately or obtusely lobed on the borders; surface hairy.

The name implies the character of the plant. It is a fragment of a frond which, in its whole, appears to have been large and rounded in outline, with undulate borders and an undulate rugose hairy surface. It exactly resembles the leaf of a *Marchantia*. From the emarginate border of the frond, come out cylindrical branches, either erect or creeping, whose form is far different from that of the frond, being similar to the basilar primary rachis of some Ferns. Their projections are about one centimeter broad, covered with oblanceolate obtuse closely imbricated scales, which appear, under the glass, very thinly striate. I compared these branches to those of some *Lycopodiaceæ*. But from what has been remarked above of the relation of some species of *Rhacophyllum* to Ferns, as a kind of prothallium, this fragment seems to represent such an organism more evidently than any other species of this genus.

Habitat—Concretions of Mazon Creek and Shale of the Coal of Colchester, Illinois.

§ 3*a*. RHACOPHYLLUM (FUCOIDS.)

Characters very variable; mostly groups of linear simple filaments, cylindrical and inflated to the apex, or flat, joined in their length and irregularly split in linear divisions.

RHACOPHYLLUM FUCOIDEUM, *Sp. nov.*, *Pl. LVIII, Figs. 6, 7.*

Filaments simple, cylindrical, filiform, slighly inflated to the obtuse apex, coming out in tufts from a common central amorphous base and flexuous, or attached to the side of a hirsute rachis.

F. 6 represents fragmants of two branches whose simple divisions coming out opposite, decline in curves towards each other, getting close together but not united at the apex. F. 7 is apparently a young plant whose axis is not yet developed, all the filaments coming out of a central point. This peculiar species has a remarkable degree of analogy to the common *Fucoides* (*Taonurus*) *Cauda-Galli*, of which we have closely allied representatives in *T. Colletti* and *T. marginatus*, Pl. A, f. 1–7. It is impossible to say if these plants are truly marine, inhabiting shallow brakish water along the borders of the coal swamps, or land plants merely related by their characters to Fucoids and already passed into the domain of the land vegetation and mixed with it. There is, it seems, an evidence of this last hypothesis in the carbonaceous substance of the plants in their state of decomposition, indicating therefore a ligneous or vascular tissue. This substance is not seen upon the remains of true marine or mere soft cellular vegetables.

Habitat—Nodules of Mazon Ceek, Mr. S. S. Strong.

RHACOPHYLLUM STRONGII, *Lesqx.*

Hymenophyllites Strongii, Lesqx., Geol. Rept. of Ill., IV, p. 417, Pl. XVIII, f. 1.

Rachis woody, undulately lineate lengthwise, covered in the lower part with long, straight, thick scales or hairs, and bearing upon short branches tufts of hairs of the same character as those of the rachis.

The specimen is not very clear and this species might have been omitted. It has however a kind of affinity to the former by the opposite direction of those tufts of hairs which, borne upon parallel branches and opposite in their direction, come together by the apex of the filaments.

These whose exact form cannot be seen, are short, straight, compressed in thick tufts and attached to the main rachis or to short branches, thus rather resembling the leaves and the divisions of trailing stems of *Lycopodiaceæ.*

Habitat—Concretions of Mazon Creek, communicated like the former by Mr. S. S. Strong.

RHACOPHYLLUM MOLLE, *Lesqx.*

Hymenophyllites mollis, Lesqx., Geol. Rept. of Ill., VI, p. 418, Pl. XVIII, f. 2–6.

Filaments thin, flat, linear, emerging from a common support, parallel at the base, joined in their length by compression, separated on the borders of the tufts in linear obtuse filaments, nerveless.

These plants, found in numerous specimens, cannot be clearly defined. They seem to grow upon fragments of decayed woody matter, and to cover them by numerous closely apressed filaments, which, by compression, form an irregular mass where their borders only are here and there distinct. In the beginning, these filaments are short, two to ten millimeters, one millimeter broad or a little more, linear, obtuse, close and parallel ; later, or in a state which seems to be their full growth, they are four to seven centimeters long, more or less flexuous, sometimes disconnected in laciniæ, two millimeters broad, irregularly lined either in the middle or along the borders, while at the apex, when distinctly separated, they have the same width and form as the primary one. These medial laciniæ, which often join again upwards, are not, therefore, separate leaves, but fragments of two or more filaments pressed and glued together.

Habitat—Nodules of Mazon Creek, not rare.

RHACOPHYLLUM IRREGULARE, *Germ.*

Aphlébia irregularis, Germ. Verst., p. 57, Pl. XXIV.

Frond large, irregularly divided from the base; divisions irregularly dichotomous, forking at the obtuse sometimes inflated apex.

This plant resembles a Fucoid, the divisions, of various length, are irregularly inflated or narrowed, three to four millimeters thick, also very irregularly branching, either dichotomous or forking in branches of various length. This species is not mentioned in Schimper's Vegt. Paleont. and is very little known. It has some features in common with the large forms of *R. adnascens*.

Habitat—I have seen only one specimen of this plant in the Museum of Comp. Zool. of Cambridge. It is without label.

Fructifications of Ferns in separate branches and of unknown attribution.

SOROCLADUS, *Lesqx.*

In considering the genus *Staphylopteris*, Presl, Geol. Rept. of Ill., IV, p. 405, I made the following remark: "Count Sternberg in his Vers. II, p. 174, defines this genus (*Staphylopteris*) merely as inflorescence or fructified panicles of Ferns, analagous to those of *Botrychium* or *Aneimia*. The only species described by the author as type of his genus, *Staphylopteris polybotrya*, from the tertiary of Europe, is represented by a small group of round sporanges. In the American species here described, the sori have various forms. But it is convenient to consider them under the same generic name until their relation to fertile fronds or their true generic affinity can be ascertained. To this genus, therefore, I refer all agglomerations of sporanges of various forms, either born upon separate plants or upon separate segments of a Fern like those of species of *Botrychium*, without visible remains of leaves, or whose connection to frond-bearing leaves cannot be traced and is unknown."

As the genus of Presl has been established on a tertiary plant, objection has been made to the use of its name for the description of fructifications of Ferns of a different character and of a different epoch. Acting upon this objection, although I do not know any more now about the true relation of the fruiting fragments which I formerly described as *Staphylopteris*, I propose this new generic name for the description of Ferns of the coal represented by fructifications whose relation is unknown.

SOROCLADUS STELLATUS, *Lesqx., Pl. XLVIII, Figs. 8–8b.*

Staphylopteris stellata, Lesqx., Geol. Rept. of Arks., II, p. 309, Pl. II, f. 2–2b.

Fruiting raceme simply pinnate, thick; branches alternate, short, in right angle, bearing four to five broadly oval or obovate sporanges, sessile and placed star-like around a central flattened axis or receptacle.

As seen on the upper branch of the right side of the figure, the sporanges are rather sessile upon the pedicel than placed at its apex, the pedicel being longer and continued under the receptacles. No relation is known to this kind of fructification.

Habitat—Male's Coal bank, Arks.

SOROCLADUS ASTEROIDES, *Lesqx., Pl. XLVIII, Figs. 9–9b.*

Staphylopteris asteroides, Lesqx., Geol. Rept. of Ill., IV, p. 406, Pl. XIV, f. 6–7b. Schp., Paleont. veget., III, p. 512.

Frond tripinnatifid; ultimate pinnæ with a narrow filiform oblique straight rachis, bearing groups of close sporanges, attached in pairs and opposite; sori globular at first, opening, when mature, in five lanceolate laciniæ placed star-like on a central round receptacle.

The specimen is represented as clearly as it can be seen. The sori, described as round before the maturity, are not seen attached upon branches of the pinnæ but on the reverse of the specimen. Their reference to the species is hypothetical. Prof. Schimper considers them as spores of *Lepidodendron* or of *Sigillaria*. Their shape is however different from that of spores of *Lycopodiaceæ* and of *Sigillariæ* which, of frequent occurrence in the coal measures, are easily recognized by their form triangular on one side. These are exactly globular, sometimes placed in two parallel rows, three or more on each side, as depending from a destroyed rachis. These fructifications may be compared to those of *Aneimia*, for the position of the sporanges at least.

Habitat—Roof shale of the Coal of Morris, Ill., Mr. Jos. Even.

SOROCLADUS SAGITTATUS, *Lesqx.. Pl. XLVIII, Figs. 10–10b.*

Staphylopteris sagittata, Lesqx., Geol. Rept. of Ill., IV, p. 407, Pl. XIV, f. 3–5.

Frond bipinnate; divisions alternate, secondary rachis thick, flexuous, decurrent or curving down to the main rachis, with alternate short thick lateral branches enlarged to the point of attachment of the fructifications; capsules enlarged at the base when open, contracted and narrowing to the obtuse apex, enclosing two rows of flat and compressed sporanges, seemingly attached to a medial smooth axis, either simple, or divided at the base in two opposite vertical branches.

The specimens, though numerous enough, are all fragmentary, the capsules, generally half imbedded into the stone, are often partly seen and therefore appear of different shape. At the top of the pinnæ they seem to be still closed; those exposed with the face upwards, as f. 10*a* and 10*b* enlarged, have the borders curved inward, slightly covering the sporanges. None of these are seen separated from the capsules. By this arrangement of the sporanges, these fructifications have a marked affinity to those of *Ophioglossum* or of *Struthiopteris*, for it is evident that what I call capsule is an involucral folding of pinnules enclosing the sporanges which appear transversely opened like those of *Ophioglossum*. The mode of division could not be remarked, however.

Habitat—Nodules of Mazon Creek, not rare. Mr. S. S. Strong.

SOROCLADUS OPHIOGLOSSOIDES, *Sp. nov., Pl. XLVIII, Fig. 11.*

Fronds pinnately divided; pedicels slender, dichotomous, bearing at the apex of the branchlets oblong, obtuse capsules, enclosing two parallel rows of sporanges.

The form of the capsules, oblong, obtuse, rounded, not enlarged at the base, and the slender pedicels, are the essential characters which separate this species from the former. The fragment of the plant, preserved in a soft shale, does not show the internal structure of the sporanges as clearly as the specimens in the ferrugenous nodules. The sporanges are distinctly separated by deep parallel lines, and their surface is convex. The shape of the sporanges relates this species still more than the former to *Ophioglossum.*

Habitat—Roof shale of the Coal of Clinton, Mo., Dr. J. H. Britts.

SOROCLADUS WORTHENII, *Lesqx.*

Geol. Rept. of Ill., IV, p. 405, Pl. XIV, f. 1, 2.

A whole pinna or frond, lanceolate in outline, pinnately divided in right angle; pinnæ alternate, sub-linear; pinnules triangular, obtuse, close, marked merely by groups of four to five large sporanges, globular before opening, or, when opened, cut into oblanceolate segments placed star-like, all without any visible points of support; primary rachis thick, its divisions narrow.

The plant is preserved in a pebble of carbonate of iron where its impression is perfectly distinct. The primary rachis is eight millimeters broad at its base, smooth and flat by compression. The lateral pinnæ are attached to the borders, sometimes inside of them upon the rachis; the pinnules, three millimeters long and as broad at base, appear as mere agglomerations of sori without trace of support, globular before opening, or when opened, cut into oblanceolate obtuse lobes, placed around a small central receptacle. Even with the specimen on hand, it is not possible to have an exact idea of the relation of the sporanges to the pinnæ as no trace of a pedicel can be seen. They appear as sessile upon the secondary rachis. But from their disposition in regular groups of a triangular outline, they were probably attached upon pinnules of the same shape whose epidermis has been destroyed by maceration.

Habitat—Mazon Creek, communicated by Mr. M. S. Hall.

RACHIOPTERIS.

Corda has described a number of generic divisions for fragments of rachis or stems of Ferns, whose characters have been studied and recognized in their anatomical structure by cross sections of silicified specimens. Schimper groups them under the name of *Rachiopterides.* As remains of this kind have not as yet been found silicified in the American coal measures, their internal structure cannot be considered, and their relation to the generic divisions established by the authors is unknown. I therefore merely describe a few fragments of these remains under the generic name of *Rachiopteris.* This name has already been admitted by Prof. Dawson for the descriptions of fragments of the same kind. As they belong to Ferns probably known from the characters of the leaves, their description is of little value. The two fragments represented in the Atl., from the coal measures, have a peculiar interest as indicating the analogy of the mode of germination and growth of the coal Ferns with that of the living ones. On his own species, Prof. Dawson remarks that they are published especially in order to show the existence in the Devonian, of Ferns whose fronds have been destroyed. Of course, the description of all the stems or rachis of Ferns found barren of leaves in the coal measures would be a useless task, as few if any of them can be determined merely from the characters of their surface. Whenever their identity has been recognized they have been considered and described with their species.

RACHIOPTERIS AFFINIS, *Lesqx., Pl. LXXV, Fig. 7.*

Stigmarioides affinis, Lesqx., Geol. Rept. of Ill., IV, p. 455, Pl. XXVII, f. 9.

Fragment of rachis enlarged and chaffy at the base, linear, nearly smooth in the upper part.

The fragment, seven centimeters long, shows, at its base, part of a rhizoma two centimeters long covered with long hairs or scales, to which is attached the blade or true rachis, one centimeter broad, bearing only a few scattered scales and grooved in the middle, as seen by two parallel distant lines.

Habitat—Concretions of Mazon Creek.

RACHIOPTERIS SELAGO, *Lesqx., Pl. LXXV, Fig. 8.*

Stigmarioides selago, Lesqx., Geol. Rept. of Ill., IV, p. 456, Pl. XXXI, f. 3, 3b.

Fragments of a rhizoma gradually enlarging downward, very chaffy, dichotomous; divisions supporting narrow linear smooth rachis.

The figure represents exactly part of a creeping rhizoma with stalks of fronds of Ferns coming out from it, as is commonly seen on specimens of living Ferns. One of the stalks is narrowed to the point of attachment, the other is broken; its covered border shows it also to have been broader than the hairy support.

Habitat—Concretions of Mazon Creek.

RACHIOPTERIS PINNATA, *Daws, Dev. Plants of N. E., Am., Quart. Journ. Geol. Soc., 1862, p. 323, Pl. XVII, f. 60.*

Stipes one and a half centimeters wide or less, unevenly striate, giving off opposite branches which are abruptly broken off at short distance from the stipe.

Habitat—Devonian of New York, with all the following species.

RACHIOPTERIS CYCLOPTEROIDES, *Daws, ibid., p. 323.*

Very thick stipes, not observed to branch and marked with uneven striæ.

RACHIOPTERIS PUNCTATA, *Daws, ibid., p. 323, Pl. XVI, Fig. 61.*

Stem marked with obscure longitudinal ridges between which are transverse furrows or punctures; greatest diameter one centimeter and a half.

RACHIOPTERIS STRIATA, *Daws, ibid., p. 323.*

Stipes regularly and distinctly striate longitudinally.

RACHIOPTERIS TENUISTRIATA, *Daws, ibid., p. 323, Pl. XIV, f. 32 a, b, and XVI, f. 45 and 46.*

Stipes smooth, finely striate, and in some specimens with linear ridges scattered over the surface and perhaps marking the position of minute hairs. Largest stem one and a half centimeters in diameter, branching pinnately and dichotomously and terminating in recurved divisions or in long flattened petioles

STIGMARIOIDES, *Lesqx.*

Fragments of rhizomas with surface marked by small round impressions (tubercles) irregularly disposed and without central vascular points. base of detached radicles or filaments.

The species of this group might be described under the name of *Rhizomopteris*, Schp., but their relation to Ferns is not ascertained, some of them at least being referable to *Lycopodiaceæ.* Grand d'Eury describes under the generic name of *Stigmaroipsis* rhizoma similar in characters to *Stigmaria*, and evidently related as roots to *Sigillaria* or *Syrigodendron.* Their scars are marked with central vascular points. Fragments of the kind described here are extremely rare. As subterranean remains and of a soft texture, they have been soon destroyed by maceration, and a few only have been preserved in the ferruginous concretions of Mazon Creek.

STIGMARIOIDES EVENII, *Lesqx., Pl. LXXV, Fig. 1.*

Stigmaria Evenii, Lesqx., Geol. Rept. of Ill., II, p. 448, Pl. XXXIX, f. 9.

Surface wrinkled lengthwise; tubercles round, close, irregularly disposed, variable in size, mostly without, some of them with an indistinct vascular scar.

The tubercles vary in diameter from one to three millimeters, and their position is very irregular; the largest ones are indistinctly marked with a central vascular point, the smaller have no trace of it. This fragment is not therefore positively referable to *Stigmaria*.

Habitat—Concretions of Mazon Creek, Mr. Jos. Even.

STIGMARIOIDES TRUNCATUS, *Lesqx., Pl. LXXV, Fig. 2.*

Lesqx., Geol. Rept. of Ill., IV, p. 453, Pl. XXIX, f. 4.

Fragment of a cylindrical rhizoma, contracted in passing into basilar branches, surface marked at variable distances and irregular distribution by small tubercles, base of rootlets as seen by a few remains attached to the borders.

This fragment is related to the former, differing by its smooth surface (not wrinkled), and by the more angular form of the scars. The few remains of rootlets still attached to the borders indicate the nature of this organism.

Habitat—Concretions of Mazon Creek.

STIGMARIOIDES VILLOSUS, *Lesqx., Pl. LXXV, Fig. 3.*

Lesqx., Geol. Rept. of Ill., IV, p. 454, Pl. XXXI, f. 1.

Fragment of a tuber, marked on the surface by two kinds of scars, most of them small, close, disposed in spiral, and a few larger ones, formed of two circular parallel rings and a central point.

The small scars are about one millimeter in diameter, generally round, angular, somewhat irregularly disposed in spiral order, two millimeters distant. The larger, two only in number, are two millimeters in diameter, similar to scars of *Stigmaria*, a little smaller. Both kinds of scars may represent the base of rootlets. From the connection of the branch with *Pecopteris villosa*, Brgt., and from the likeness of the dots of the surface of the fragment to those upon the rachis of the Fern, this organism may be supposed to represent part of a rhizoma of this species, broken near the point of its attachment to the rachis. The spiral distribution of the scars however is not like that of scales or thick hairs of the rhizoma of a Fern.

Habitat—Concretions of Mazon Creek.

STIGMARIOIDES TUBEROSUS, *Lesqx., Pl. LXXV, Fig. 4.*

Lesqx., Geol. Rept. of Ill., IV, p. 453, Pl. XXIX, f, 5.

Tuber oval in outline, slightly emarginate at base, contracted in the upper part in passing to a leaf or smooth rachis, surface irregularly dotted by very small points, marked in the upper part by a single stigmaroid scar.

This organism may be of the same nature as the former. It is three and a half centimeters long, two and an half broad, inflated or convex, perfectly entire at the base and the sides, contracted to a leaf which appears to join it by a narrow neck. This is broken; the mode of union of both parts is not visible. The upper appendage resembles a fragment of a large leaf of *Stigmaria*, rather than a petiole, and the leaves of *Stigmaria* sometimes bear at their extremity tubercular vesicles, about the same size as the one figured. The dotting of the surface however and the round scar under the neck indicate the nature of the organism as that of a tuber, bearing a smooth rhizoma or perhaps the base of a rachis.

Habitat—Concretions of Mazon Creek.

STIGMARIOIDES LINEARIS, *Lesqx., Pl. LXXV, Fig. 5.*

Lesqx., Geol. Rept. of Ill., IV, p. 455, Pl. XXXI, f. 2.

Part of a root or nearly linear rhizoma, gradually and slightly narrowing from the top to the base, bearing rootlets in irregular position.

Evidently part of a root, too regular for a rhizoma of Fern. The fragment, ten centimeters long, one centimeter at the upper broken end, eight millimeters at the base, flat by compression, bears, like f. 2, remains of still attached radicles and small round scars left by those which have been detached from it. The radicles somewhat variable in size are at least twice as broad as the scars which are only two millimeters in diameter. They are all tending downward from the axis.

Habitat—Concretions of Mazon Creek.

Stems or Trunks of Ferns.

Trunks of Ferns are represented in the coal measures in two different ways, either by silicified whole fragments, generally transverse sections of trunks, or merely by pieces of the bark, preserved in the shale and characterized by the configuration of impressions, marking the points of attachment of the petioles. As Tree-ferns are now cultivated in the conservatories, they are generally known. The similarity of the figures which represent these points of attachment in a fossil state will be easily recognized by those who have seen Tree-ferns of our time. These scars are generally oval in outline, placed in spiral, though sometimes contiguous or joined at their ends, thus seemingly in longitudinal series. According to their characters, which are peculiar, varied indeed, and apparently specific, the plants which they represent may be considered in the four following generic divisions:* *Stemmatopteris*, *Caulopteris*, *Megaphytum* and *Psaronius.*

Tree-ferns are common enough in the coal flora of this continent, while in Europe they are rarely found, and, according to Grand'Eury, mostly limited to the strata of the upper coal measures. Goeppert has some species from the Permian under the generic name of *Protopteris* and *Caulopteris.* We have them already in the Devonian as seen from the species described by Dawson and Newbury. None as yet are known from the sub-conglomerate coal, and none either from above the Pittsburg coal. They are locally very abundant. In the shale of the coal they bear in their distribution the same proportion as trunks of living trees may bear to the amount of remains deposited for successive years by their branches and foliage.

Trunks of *Psaronius* are found mostly in South Ohio, on Shade river, and in Kentucky, along the Great Kanawha river. They are derived all from the same horizon, a heavy Sandstone underlying the Pittsburg coal.

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* I admit with some modifications of the characters the generic divisions of Schimper Veget., Paleont. The whole number of our species could have been described without inconvenience under the name of *Caulopteris.*

STEMMATOPTERIS, *Corda.*

Trunks erect, cylindrical; scars large, disciform, oval round or ovate, not contiguous, disposed in quincunxial or spiral order; outside borders or rings flat; internal disk formed by impressions of fascicles of vascular tissues, shaped like a horse-shoe, the horns curving inward in the upper part of the scars, either short and hooked, or descending below the middle of the scars and there united.—Atl., Pl. LIX.

STEMMATOPTERIS HIRSUTA, *Sp. nov. Pl. LIX, Fig. 1.*

Scars of medium size, exactly oval; borders large; disks scarcely broader in the middle, slightly curving up to the horns, which are short, at a distance from each other; borders fringed by short scales or hairs; epidermis of the bark grained like shagreen.

The scar are seven centimeters long and four broad, the flat borders about one centimeter; the surface of the disks is marked by prominent smooth vascular dots, irregular in size and distance. A specimen from Oliphant bears scars ten to fifteen centimeters in vertical distance, five to six in horizontal, with scales somewhat larger at the base. Another from Cannelton has the bark grained like shagreen.

Habitat—Concretions of Mazon Creek, finely preserved, Mr. S. S. Strong. Shale of coal No. 1 of Oliphant, Pa. cabinet of Mr. R. D. Lacoe; Cannelton coal, Mr. I. F. Mansfield.

STEMMATOPTERIS EMARGINATA, *Sp. nov.*

Scars larger than in the former species, oval, rounded on the lower end, emarginate at the other; borders broad and surface smooth; disks divided into two opposite semilunar lobes by the vascular impressions.

The scar is nearly eight centimeters long, four centimeters broad; the disk is divided into two separate lobes, each irregularly oval, the outside line parallel to the borders, the inside close at both ends, more distant in the middle or semi-lunar in opposite directions. The vascular impression is somewhat like that of Atl., Pl. LIX, f. 4, with this difference, that the medial lines descend to the base and join it by an outside curve, dividing the disks in two halves. It is not possible to see which end of the scars is the upper. This scar may be that of a *Megaphytum.*

Habitat—Cannelton, Pa.; Mr. I. F. Mansfield.

STEMMATOPTERIS SCHIMPERI, *Sp. nov.*

Stem long and small, covered with a coating of rootlets; leaf scars distant, long, narrowly oval, obtuse at both ends, distinct, even under the thick coaly layer, distant and alternate; vascular impressions horse shoe shaped; horns short, nearly contiguous in their curve.

The stem measures at least one meter in length, and its width does not average more than eight to nine centimeters in the whole length. The scars are alternate, very distant, twenty centimeters from the base of one to the top of the lower one in the series, but transversely close, three to four centimeters, also between the corresponding or opposite cicatrices. Leaf scars eight centimeters in length, two centimeters in width, the disks much shorter, only four and a half centimeters long and twelve millimeters broad in the middle. The internal surface of the disks is rough or irregularly punctate and wrinkled lengthwise. The whole stem is covered by a coating of coal one to two millimeters thick, representing the upper surface or bark with the rootlets covering it, but passing aside of the leaf scars.

The cicatrices are comparable by their shape to those of Pl. LIX, f. 2; they are however much narrower, as are also the lateral borders, while the disks being shorter, the space at the lower and upper part is wider. By the coating of rootlets and the distance of the scars it resembles the following species, but the rootlets are thicker and very long, as no trace of points of attachment can be seen upon the stems. From the base of the stem, bundles of leaves of *Tæniophyllum decurrens* (Pl. LXXXI, f. 1) come out, diverging on an acute angle as in the figure, seemingly attached to the rootlets which, however, are narrower in size and cover the stem without divergence. These leaves bearing macrospores have been described with the group of plants doubtfully referable to *Lycopodiaceæ.*

Habitat—Cannelton, Pa., recently discovered by Mr. I. F. Mansfield.

STEMMATOPTERIS SQUAMOSA, *Sp. nov., Pl. LIX, Fig. 2.*

Scar narrowly oval, obtuse at the base, emarginate at the upper end, borders large, flat and smooth; impressions narrow, confluent at base; horns short curving to the continuous line of the central oval disks; borders scaly.

The scar is comparatively narrow, nine centimeters long, a little more than three centimeters broad; scales of the borders nearly one centimeter long, lanceolate acuminate, turned downwards.

Habitat—Cannelton, Mr. I. F. Mansfield.

STEMMATOPTERIS ANGUSTATA, *Sp. nov., Pl. LIX, Fig. 5.*

Differs from the former species by its smaller size and the borders without scales.

The scars are only five centimeters long and twenty two millimeters broad. By their shape, they might be supposed to represent the same species as the former. But no trace of scales is seen, either upon the borders of the scars, or upon the fragment of smooth shale where they are preserved.

Habitat—Same as the former.

STEMMATOPTERIS PUNCTATA, *Lesqx., Pl. LIX, Fig. 3.*

Caulopteris punctata, Lesqx., Geol. of Penn'a, 1858, p. 869, Pl. XIII, f. 1.

Scars nearly exactly oval or slightly obovate; borders flat; internal disks narrow, enlarged upwards; vascular lines joined at the horns; surface of the bark punctate the dots representing base of hairs or of scales.

This species is closely allied to *S. peltigera* (*Sigillaria*, Brgt.). It has larger scars and the bark roughened by larger obtuse tubercles. It is rare and generally found in specimens bearing a number of scars all of the same size as those of the figure.

Habitat—Gate Vein, New Philadelphia, Pa. Cannelton, Mr. I. F. Mansfield. Mr. R. D. Lacoe has some splendid specimens which seem intermediate in their characters between this species and *S. peltigera.* This renders the separation of *C. punctata* somewhat doubtful. These last specimens are from Oliphant, No. 1 vein and Port Griffith, Pa., F ? vein.

STEMMATOPTERIS INSIGNIS, *Lesqx., Pl. LIX, Fig. 7.*

Caulopteris insignis, Lesqx., Geol. Rept. of Ill., II, p. 459, Pl. XLIX, f. 1.

Scars very large, exactly ovate; borders large and flat; vascular impressions parallel to the borders, with curves distant, descending parallel to near the basal line where they unite, forming a spatulate obtusely pointed medial rib.

A very remarkable species represented by the largest and best preserved scar of a fossil Fern-tree seen until now. The bark, which from want of place is not figured here, is smooth; the scar twelve centimeters long, eight and a half centimeters broad, is exactly ovate, with a smooth border two centimeters broad and an internal disk horse shoe shaped with the curve of the horns distant, but the border lines continuing downward and joined only near the base of the disk. On both sides of the branches, near their point of connection and on each side, are marked two narrow lines parallel to the branches and scythe shaped, bordering an internal area irregularly dotted by points apparently the remains of filiform vessels.

Habitat—Shale of Duquoin Coal, Ill., two specimens of the same size in the State cabinet

STEMMATOPTERIS GIGANTEA, *Lesqx.*

Caulopteris gigantea, Lesqx., Geol. of Penn'a, 1858, p. 869, Pl. XIII, f. 2.

Scar large, obovate, with a broad double border; branches of the vascular scars diverging, horns hooked, distant.

The scar is a little more than half as large as the former.

Its shape contrary to that of most of the other species is obovate, enlarged upwards ; the broad border, twelve millimeters, is distinctly divided into two rings of equal width, the outer apparently thicker. The horns are seven millimeters distant, the line of vascular bundles thick, at least two millimeters.

Habitat—The specimen was in the cabinet of Mr. Clarkson, of Carbondale, and figured there in 1852.

STEMMATOPTERIS CYCLOSTIGMA, *Sp. nov.*

Scars large, in quincunxial order, about two centimeters distant in oblique direction, nearly round ; surface smooth ; branches of the disks parallel to the borders, horns distant in half circle.

The scars are seven to eight centimeters both ways ; the disks, two and a half centimeters broad, are bordered by a deep narrow vascular impression following the same curve and thus parallel to the borders of the scars, with the horns hooked and opposite, the space between the inside curve being six to eight millimeters. The surface of the disks and of the scars is exactly smooth as also the surface of the stem between the scars, marked only by distant small verrucose tubercles ; a few of them are seen upon the borders of the cicatrices.

Habitat—Oliphant, Pa., Coal No. 1. Specimens in the cabinet of Mr. R. D. Lacoe, of Pittston.

STEMMATOPTERIS MIMICA, *Sp. nov., Pl. LIX, Fig. 4.*

Annular scars small, truncate at the top, abruptly contracted near the very obtuse base ; disk somewhat enlarged in the upper part, the branches curving at a distance from the borders and descending parallel to near the base of the scar ; appendages half round parallel to the upper curves ; surface smooth.

The disk is, in its shape, remarkably similar to a man's face, the decending branches of the inside impressions having, in their parallel disposition, the shape of a nose and the lines under the curves that of the eye brows, while the lower part of the ring is abruptly narrowed into the shape of a broad chin. The scars are about four centimeters long and nearly as broad.

Habitat—Cannelton, Pa.. Mr. I. F. Mansfield.

STEMMATOPTERIS POLITA, *Sp. nov.*, *Pl. LIX*, *Fig. 6.*

Outside rings transversely oval; internal scars rounded at the base, enlarging upwards in diverging branches, abruptly curved inside and joined in the middle in transversally oval knots or horns; surface very smooth polished.

The scars are transversely oval, four and a half centimeters broad, three centimeters in vertical length, joined by the borders in spiral order, like the scars of *Lepidodendron*. The inside disks, kidney shaped in outline, are formed by deep vascular lines, at first curving upwards in opposite directions, then abruptly bending towards each other and joined by transversely hooked horns, the lateral branches projecting beyond the capping line of the disks, which are two centimeters broad in the upper part, one and a half centimeters in vertical direction. The specimen is regretably too small, a piece of bark of an apparently young tree, the epidermis being very thin and remarkably smooth.

Habitat—Cannelton Coal, Mr. I. F. Mansfield.

STEMMATOPTERIS WORTHENII, *Lesqx.*

Caulopteris Worthenii, Lesqx., Geol. Rept. of Ill., II, p. 459, Pl. L, f. 1.

Stem slender; scars very distant, rounded at the base, narrowed upwards; internal impressions horse-shoe shaped, with horns converging; vascular scars parallel to the borders, marked above the base by a semi-lunar appendage.

The stem seven to eight centimeters in the widest diameter, reduced by compression or flattened to half this thickness, bears four distant scars, one of which only is well preserved. It is four centimeters long, two and a half centimeters broad, contracted above to an emarginate apex only five millimeters broad. The scars are about twenty-five centimeters distant in vertical line. The vascular impressions, following parallel to the flat outline of the borders, are slightly narrowed to the upper part, curved into two confluent horns, the line of connection descending lower, or nearly to the middle of the scar. The impressions are more or less obliterated by erosion, one of them being exactly elliptical and all without dots or traces of cylindrical vessels.

Habitat—Carmi, White county, Ill., upper coal measures.

CAULOPTERIS, *Ll. and Hutt.*

Scars with the inside disk either marked by linear bands, remains of vessels passing from the trunk to the base of the rachis, or covered by impressions of rootlets obliterating its shape, or merely ovate or elliptical, without traces of horse shoe shaped vascular lines. These lines may have been, in some cases, effaced by abrasion of the surface or covered by rootlets.

CAULOPTERIS GIFFORDI, *Sp. nov., Pl. LX, Figs. 1, 2.*

Stem originally cylindrical, half flattened by compression; scars in longitudinal series, large, subcontinuous, elliptical, marked lengthwise by longitudinal deep impressions.

The specimen is a silicified stem, seventeen centimeters broad, reduced by compression to a thickness of four centimeters in the middle. The scars, six and a half centimeters long, three and a half broad, are regularly elliptical, deeply grooved into the stone, marked by longitudinal elevated narrow ribs, which, when destroyed, leave the surface under them nearly smooth. The bark between the scars is thick, about one millimeter, verrucose, the warts generally directed lengthwise and oval.

The internal structure is indistinctly seen, f. 2, in woody fasciles of dark color, linear, flexuous, irregularly divided, diversely mixed in the cellular tissue, somewhat disfigured by compression. The disposition of the vessels is like that figured by authors from species of *Psaronius*, comparable especially to *P. pulcher*, Corda, Beitr., p. 96, Pl. XXIX, f. 5.

The species is closely allied to *C. Phillipsii*, Ll. and Hutt., II, Pl. 140, differing by the shape and size of the scars, longer and narrower, joined by a narrow neck.

Habitat—This beautiful specimen was kindly presented to the survey by Mr. Wm. Gifford, as found in the coal measures near Alta, Peoria county, Ill.

CAULOPTERIS LACOEI, *Sp. nov.*

Fragments of a flattened stem, one hundred and fifty centimeters long, twenty centimeters in diameter, with four longitudinal rows of alternate ovate scars, six to seven centimeters long, four to five broad, at an average distance of one and a half to two centimeters, both ways, marked lengthwise with regular vertical striæ, evidently remains of linear bundles of vessels, independent of the flexuous striæ, impressions of rootlets which cover the surface of the bark between the scars.

No traces of vascular impressions are seen, except two lines curving downward, in an obtuse angle of divergence from the middle of the disk. The outside ring is narrower in the upper part; the shape of the scars, twice as broad near the base as near the top, is exactly ovate.

I refer to the same species another specimen with scars exactly round, much smaller, placed in the same relative position, not quite as distant, covered like the bark with flattened rootlets, under which is obscurely seen a central disk like a horse-shoe shaped vascular impression. It may represent a different species.

Habitat—Both specimens are in the cabinet of Mr. R. D. Lacoe, obtained from coal No. 1 of Oliphant.

CAULOPTERIS OBTECTA, *Lesqx., Pl. LIX, Fig. 8.*

Geol. Rept. of Ill., IV, p. 457, Pl. XXVIII, f. 1-4.

Stems of small size, covered with linear roots; scars generally distant, elliptical; disks obsolete by the covering of the rootlets.

The filaments, remains of flattened rootlets, three millimeters in diameter, exactly linear, are seen derived from under the bark, where they leave small or narrowly oval scars at their point of attachment. By their superposition and compression, they cover the stem by a coating of carbonaceous matter more than one millimeter thick. The scars have all been covered by these radicles after the falling off of the petioles, and therefore, though their outline is perceivable, the internal disk is indistinct Even after abrasion of the coaly surface, the impressions of the radicles leave irregular vertical lines, merely interrupted towards the top of the disk, as seen in the figure which is reduced to one fourth the size of the specimen. The vertical distance between the scars is very great, sixteen centimeters. On another specimen, whose scars are not quite as large, four and a half centimeters long, three and a half broad, the distance is reduced to eleven centimeters. As seen from the specimen, the distance is very variable, even upon one and the same fragment of stem.

Habitat—Shale of the coal of Morris, Ill. The specimen figured is in the Museum of Comp. Zool. of Cambridge. Cannelton, Penn'a, in fine specimens—Mr. I. F. Mansfield.

CAULOPTERIS CISTII, *Brgt.*

Sigillaria Cistii, Brgt., Hist. d. veg. foss., p. 418, Pl. CXL, f. 2.

Caulopteris Cistii, Gein., Verst., p. 31, Pl. XXXIV, f. 1, 2. Lesqx., Geol. of Penn'a, 1858, p. 869.

Stemmatopteris Cistii, Corda, Beitr., p. 76. Schp., Paleont. veget., p. 710.

Stem large, surface covered with adventive rootlets descending between the scars which are placed in quincunxial order, vertically distant; internal disk narrowly elliptical, a little broader at the base, slightly emarginate at the top; surface clotted, rugose.

The border of the scars is large, but often partly covered or obliterated by the impressions of rootlets which fill the lateral space between the scars, while under them the surface is left uncovered of radicles or smooth, for half or even for the whole distance between them. The vertical distance is not less than twelve centimeters, sometimes much greater. With the ring the impressions average six to seven centimeters long, and a little more than two and a half centimeters broad. The internal disk is generally narrowly elliptical, obtuse at both ends, sometimes also emarginate at the upper end, as by horse-shoe shaped vascular impressions. From this character, the species should be described as *Stemmatopteris*. But the disks are rarely distinct, and the whole surface is very rugose lengthwise, as dotted by irregularly round, even linear impressions of small fasciles of vessels. All the specimens examined are flattened or generally large pieces of bark, except the following.

This one, in the Museum of Comp. Zool. of Cambridge, is a fragment of a slender, cylindrical, slightly compressed stem, nine centimeters in the widest diameter, flattened to five and a half centimeters, marked by elliptical scars, ten centimeters long, only two and a half broad, obtusely pointed at both ends, with central disks shorter and placed towards the upper part of the scars. The specimen, which I labeled *Cyclopteris elongata*, Sp. nov., may be a variety of *C. Cistii*, though the surface of the stem is smooth and without radicles. This last difference is not of specific value, for the adventive radicles seen upon many species of Fern-trees of our time, generally cover the base or the lower part of the trunks, even as high up as the middle, but gradually disappear towards the top.

Habitat—The species is not rare in the coal measures. Found at Cannelton, by Mr. I. F. Mansfield; at Oliphant, by M. Jones, No. 1 vein; at Pittston; E vein of Port Griffith, Mr. R. D. Lacoe; also in the coal shale of Morris, Ill., etc. The specimen of the Museum of Comp. Zool., is from Cambridge, Ohio, Upper Coal Measures.

CAULOPTERIS MANSFIELDI, *Sp. nov., Pl. LX, Fig. 2.*

Scars large, oval, oblique, close; borders very broad, formed of a double ring; internal disks convex, oval, rounded at the base, obscurely emarginate or truncate at the top; surface deeply striate by impressions of flexuous rootlets, filling all the space between the scars.

Differs essentially from *C. Cistii*, by the close position and the large size of the scars, with borders formed of a double ring, more than one centimeter broad, the outer part smooth, the inside more or less rugose or dotted, six to eight centimeters distant only, in vertical direction. The two specimens which I have seen of this species show the scars oblique to the vertical plane of the axis.

Habitat—Cannelton, Pa.; Mr. I. F. Mansfield.

The descriptions of the following species, from the North American Devonian, are copied from Prof. Dawson.

CAULOPTERIS LOCKWOODI, *Daws.*

Quart. Journ. Geol. Soc., Aug., 1871, p. 270, Pl. XII, f. 1–3.

Trunk two to three inches in diameter, longitudinally rugose; leaf scars broad, rounded above and radiatingly rugose, with an irregular scar below, arranged spirally in about five ranks; vascular bundles not distinctly preserved; petioles slender, much expanded at the base, dividing at first in a pinnate manner, and afterwards dichotomously; ultimate pinnæ with remains of numerous apparently narrow pinnules.

The author remarks that the specimens allow him, at least, to conjecture that the trunks may have belonged to Fern-trees, although none of them are sufficiently perfect for description.

Habitat—The Chemung group, near Gilboa, New York.

CAULOPTERIS ANTIQUA, *Newby.*

Daws., l. c., p. 271, Pl. XII, f. 4.

Flattened stem about eighteen inches long, three and a half in average breadth; the exposed side shows about twenty-two large leaf scars, arranged spirally, each leaf, when broken off, has left a rough fracture; and above this there is a semi-circular impression of the petiole against the stem, which, as well as the surface of the bases of these petioles, is longitudinally striate and tuberculated; the structures are not preserved, but merely the outer epidermis as a coaly film.

Habitat—Marine limestone, containing Brachyopods, Trilobites, etc., of the corniferous limestone of Ohio.

CAULOPTERIS PEREGRINA, *Newby.*

Daws., l. c., p. 272, Pl. XII, f. 5, 6.

The upper part of the specimen, eight centimers in diameter, about thirty centimeters in length, shows thirty leaf scars, about two centimeters wide, and rather less in depth; the upper part of the scars presents a distinct and sometimes double marginal line, sometimes with a slight depression in the middle. The lower part is irregular, and when most perfect, shows seven slender vascular bundles, passing obliquely downward into the stem. The lower perfect leaf bases have the structure preserved and show a delicate thin-walled oval parenchym, while the vascular bundles show scalariform vessels, with short bars in several rows, in the manner of many modern Ferns; some of the scars show traces of the hypocrepian marks, characteristic of Protopteris, and the arrangement of the vascular bundles at the base of the scars is the same as in that genus, as are also the general forms and arrangement of the scars.

A second specimen is covered with a mass of flattened ærial roots, these being parallel to each other in the manner of the *Psaronites* of the coal formation.

Habitat—With the former.

MEGAPHYTUM, *Artis.*

Scars large, round-quadrate in outline, mostly contiguous, placed in opposite biserial rows; internal disks convex, with central or vascular impressions in the form of a horse shoe, or a medial band dividing the disks into two lobes, joined in the middle.

The disposition of the petioles in two opposite rows and close to each other is very peculiar, and not seen in any Fern-trees of the present time.

MEGAPHYTUM MCLAYI, *Lesqx.*

Geol. Rept. of Ill., II, p. 458, Pl. XLVIII. Schp., Paleont., veget., I, p. 715.

Scars large, nearly square in outline, contiguous or somewhat distant; borders flat, large, smooth, internal disks deeply emarginate at the top and deeply cordate at the base by the vascular line passing up and down to near the middle; bark of the trunk smooth.

From two good specimens, one in the collection of the Museum of Comp. Zool. of Cambridge, the other communicated by Mr. Mansfield, I am able to see exactly the characters of the disks, and the essential differences which separate the species from the following. The scars, twelve centimeters long, nine broad, including the flat borders, are square in outline, rounded at the corners. The borders average two centimeters in width, being a little narrower on the sides. The disks are seven centimeters broad at the enlarged rounded deeply cordate base, gradually narrower toward the round top, which is also deeply emarginate or obcordate by the vascular impressions. These, curved in horse-shoe, enter the disk both at the upper and lower part, by branches or linguiform appendages which divide it nearly to the middle. In the figure of the Geol. Rept. of Ill., l. c., the division appears continuous from the top to the base of the disks; but the specimens first obtained and copied were not in as good state of preservation as those I have received since. The borders of the scars are not always contiguous; sometimes there is a distance of three to four centimeters between the scars, as seen in a specimen from Morris. The epidermis of the bark is smooth or without tubercles.

Habitat—First discovered in the coal of St. John, Ill., by Mr. John McLay. The specimen of Cambridge, presented to the museum by Dr. Hand, is from Morris. The third is from Cannelton, found by Mr. I. F. Mansfield.

MEGAPHYTUM GOLDENBERGII, *Weiss—Pl. LXI, Fig. 4.*

Weiss, Zeitsch. d. deutsch. geol. Gesellsh., XII, 1860, p. 510. Schp., Paleont., veget., I, p. 7.3, Pl. LV.

Scars transversely oval, joined by the borders, obscurely *divided into two rings by a parallel thin line; disks of the same form, marked by small irregular perforations, especially near the base; central disks small, deeply obcordate; bark tuberculate.*

Schimper, l. c., has two splendid figures of this species, showing both sides of a specimen forty-three centimeters long and thirty centimeters broad, flattened. The scars of the American specimen, which is represented partly in Atl., are larger, eleven centimeters in horizontal direction, and six centimeters in vertical line. The shape of the scars and of both the internal and outside disks are exactly the same. The internal disk is comparatively small, also transversely oval, three centimeters in the horizontal direction, half as wide in the other. The surface is somewhat obliterated by compression, and the division of the internal disk is obscure. It is marked in Schimper's figure as nearly split or deeply emarginate by the vascular impressions descending linguiform to below the middle. The tubercles of the bark are irregularly conical, perforated or funnel-shaped in the centre; they are obscurely reproduced by concave impressions upon the borders and the disks.

Megaphytum magnificum, Daws., Quat. Journ. Geol. Soc., vol. XXII, Pl. VIII, f. 34, from the coal of the Joggins, Canada, is closely allied to this species.

Habitat—Shale of the Clinton coal, Mo.—Dr. I. H. Britts.

MEGAPHITUM GRAND' EURYI, *Sp. nov.*

Trunk large, covered with appressed adventive radicles derived from oval tubercules irregularly placed upon the stems. Scars large, contiguous, transversely oval; disks broad, of the same form, the lower and lateral borders parallel to those of the scars, horse-shoe shaped at the top, or curved in two horns, the lines, fasciles of vascular bundles, descending by a slight divergence to near the base of the disks, there connected by a crescent-shaped line forming a spatulate tongue; appendages distinct, nearly joined to the middle of the tongue, diverging outward in descending and abruptly curving inward to near the base of the *tongue; surface of the disks and scars marked by irregularly scattered verrucose obtuse smooth mamillæ of various size, more numerous on the insides of the disks.*

The fragment represents part of a flattened stem, thirty centimeters in diameter, one side of which only is seen. The scars measure transversely ten to eleven centimeters and vertically six; the borders are continuous, without line of separation between them. The disks seven centimeters broad laterally, four in vertical direction, follow in a broad curve and parallel to the borders of the scars, to the upper part, where the lines of the vascular bundles curve and pass nearly straight toward each other, bending abruptly downwards when at a distance of one centimeter and descending with a slight divergence toward the base of the disks where they are joined by a broadly obtuse line of connection. The shape is exactly horse-shoe shaped, the medial tongue descending as low as in *Stemmatopteris insignis*, Pl. LIX, f. 7 and being of the same shape, only more enlarged and more obtuse at the base. On both sides and as seen also upon that same figure, l. c., the tongue is bordered from below the middle by two appendages which, coming out from below the middle of the tongue, rapidly diverge from it to one and a half centimeters distance and then abruptly curve inward toward the base, effacing before reaching it. Of a different shape they represent the appendages at the base of the tongue of Pl. LIX, f. 7. The surface of the disks and scars is quite smooth, except for the tubercles, which, few and distant upon the border of the scars, are numerous in the inside of the disks, equally distributed also, but less distinct upon the surface of the tongue. The trunk, outside of the scars, is covered with closely appressed flattened radicles averaging three millimeters in diameter. They seem derived from numerous pustulate scars, four to five millimeters long, half as broad, irregularly placed upon the stem.

The annular scars of this Fern have a close affinity of character to those figured, without specific name and description, by Grand 'Eury, Fl. Carb., Pl. XIII, f. 3. The scars and disks are much larger in the American form; the distance between the disks at least twice as great, two and a half centimeters; the vascular lines forming the tongue are not parallel, but diverge toward the base and descend lower; the radicles, as seen upon the figure given by the French author, are much larger. But this character may not be worth considering.

If the nature of *Megaphitum* was not already definitely ascertained to be that of a Fern-tree, this species, by the identity of the characters of the disks with those of *Stemmatopteris*, would sufficiently prove its close relation to this genus. Considering merely the scars of Tree-ferns, as we have them for the specific determination of these plants, there is scarcely a definite line for generic division between them.

Habitat—Oliphant No. 1 vein Mr. Ed. Jones; the cabinet of Mr. R. D. Lacoe.

MEGAPHYTUM PROTUBERANS, *Lesqx.*

Geol. Rept. of Ill., II, p. 458, Pl. XLVII, f. 1, 2.

Scars gibbous, square-oval, rounded at the base, slightly emarginate at the top where the transversely broad ovate disk is placed; vascular impressions horse-shoe shaped or reniform, with horns curved up and hooked.

The specimen is represented upside down, as remarked by Prof. Schimper. The central disk and vascular impressions should, therefore, be described as basilar with horns turned up. The space between the base of the scars and the disk is, however, much inflated, and seems to show the lower descending part of a petiole rather than the facing of its internal part. The same disposition as that of this figure is remarked in *M. frondosum*, Artis., Antedil. Phytol., Pl. XX, a species to which this one is related by the form of the scars and the striate surface of the bark. It is however in contradiction to what is known of the direction of the vascular impressions, in living Ferns. The scars including a narrow border are six and a half centimeters long, four centimeters broad in the middle. The disks whose outlines are somewhat obscure and blended with the underneath inflated bolsters, are two and a half centimeters, transversely, and only two and a half in vertical direction. The branches of the reniform impressions are two centimeters apart, curved and hooked at a distance from each other, with an indistinct irregular round or oval scar in the middle.

The specimen bears eight contiguous scars; the bark is irregularly striate lengthwise.

Habitat—Carmi, White county; specimen in State cabinet of Illinois.

PSARONIUS.

To this genus are referred stems of Tree-ferns, covered in the inferior part by adventive roots, increasing by their superposition the conical base of the trunks. The cortex is thick, parenchymatose; the woody cylinder is subdivided into branches composed of fascicles of vessels, either half cylindrical or diversely plicate, immersed in the cellular medullar tissue. These vascular bundles affect in their curves and subdivisions very variable dispositions, as may be seen in the cross sections, Pl. LX, f. 2. The specific characters are recognized by the analysis of the internal structure, made on silicified cross sections, by the cutting and polishing of thin lamellæ. They are too different and varied to be understood without figures; and though I have collected a considerable number of specimens of those trunks of *Psaronius*, I have not been able to obtain the necessary assistance of a lapidary for their specific identification. They abound, as remarked already, in the Sandstone (Mahoning) of Southern Ohio, on Shade river, and in Kentucky along the lower Kanawha river. The adventive roots which cover the cortical parenchyma of the stem, even enter it and become part of it, are often found expanded at the base of the trunks and compressed in large flattened stumps of very irregular shape, with a conical medial projection, base (mostly destroyed) of the stems of which they were the supports. The same arrangement of adventive rootlets, surrounding the base of Fern-trees increasing in thickness and in strength as fast as the trees ascend higher, is seen on species of Tree-ferns of our time. The trunks of Shade river vary in thickness from ten to thirty centimeters; rarely are they found smaller but sometimes larger. For I obtained from that locality a remarkably well preserved cylindrical trunk, two feet in diameter which is now in the Museum of Comp. Zool. of Cambridge.

The cabinet of Dr. Hildreth, presented to the college of Marietta, Ohio, has some of these stems of *Psaronius* polished in transverse sections. Even some have been prepared as deck-boards of small tables, forming, in their arrangement, variegated and beautiful designs, according to the peculiar distribution and shape of the vessels, as distinct upon the polished surface as might be the venation of marble.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:
REPORT OF PROGRESS.

P.

DESCRIPTION OF THE COAL FLORA OF THE CARBONIFEROUS FORMATION IN PENNSYLVANIA AND THROUGHOUT THE UNITED STATES.

VOL. II.

1. Lycopodiaceæ.
2. Sigillariæ.
3. Gymnosperms.

BY

LEO LESQUEREUX.

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DETERMINATION AND DESCRIPTION

OF THE

VEGETABLE REMAINS

FOUND IN THE

COAL MEASURES OF THE U. S. OF NORTH AMERICA.

SECOND PART.

VASCULAR CRYPTOGAMOUS PLANTS.

LYCOPODIACEÆ.

At the present epoch, the plants of this order, *Lycopods*, *Selaginella*, *Isoetes*, generally inhabit low, mossy places, under the deep shade of the forests, or the surface of the bogs, or the grassy slopes of the mountains, where atmospheric humidity prevails to a high degree. The few species which thrive upon dry rocks exposed to solar action, have the faculty of closing their leaves, even their stem, one upon another, in dry weather, opening them only, when humected by rain or fogs, to continue their interrupted growth. *Isoetes* species are either aquatic or amphibious.

From the habitat of the *Lycopodiaceæ*, at the carboniferous epoch, we derive indications of the atmospheric circumstances which have exercised their influence upon the vegetation of the coal, whose combustible matter is composed in a great proportion of plants of this class, which flourished to a very high degree of luxuriance during the whole period of the Carboniferous. For the *Lycopodiaceæ* were not then small herbaceous trailing plants, like those living now, but trees of a size equaling that of the largest arborescent plants of our time. Schimper says that trunks of *Lepidodendron* have been found one hundred feet long and ten to twelve feet in diameter. I have never seen any of this enormous size; but cylindrical stems or mere fragments of stems of this kind have been frequently observed forty to fifty centimeters thick, or more, either flattened in the roof shale of the coal, or preserved in their cylindrical normal shape in the sandstone.

The leaves of the *Lycopodiaceæ* are generally in a spiral order, modified sometimes in their relative disposition, even in the same species. They are narrow, linear-lanceolate, of various length according to species, all with a strong midrib. Their point of attachment upon the stems is marked by scars of divers forms, which greatly vary in size, according to the age of the fragments, or rather of the part of the tree from which the fragments of bark are derived. It is essentially from the characters of these leaf scars that species of the *Lepidodrendræ* have been established.

The fructifications, rarely found attached to their support, are in cylindrical or ovate spikes, sessile or pedicellate, composed of sporanges attached to the anterior base of leaves or blades of various forms, which, curved upwards and imbricated, cover the outside of the cones. The sporanges contain organisms of two kinds, either very small ones (microspores), which are like powder or agglutinated globules of matter, distinct only with microscopes of great power. They may represent the male fertilizing pollen. Or, and more generally, they contain macrospores, large, true globular seeds, angular on one side, rounded on the other, as seen in Atl., Pl. LXVIII, f. 7, 7*b*, or Pl. LXIX, f. 9, 9*a*.

As representatives of the *Lycopodiaceæ*, we have in the American coal measures, with a few *Lycopodites*, the following genera, which are separated by Schimper into the family of the *Lepidodendræ*;—*Lepidodendron*, *Ulodendron*, *Knorria*, *Lepidophloios*, *Halonia*, *Lepidostrobus*, *Lepidophyllum*, and analogous organs of fructifications: *Lepidocystis*, *Sporocystis*.

I consider also as related to this order, from the nature of its fructifications, the genus *Tæniophyllum* formerly referred to the *Cordaiteæ* from the characters of its long ribbon-like leaves. *Psilophytum*, Daws., is placed in the Lycopodiaceæ by its author.

Lycopodites et Selaginites, (Auct.)

Plants herbaceous; leaves of the same or of two different forms upon the same branches, distichous or in spiral order; fructifications in small cylindrical spikes.

A few of these plants are species of true *Lycopodium*. They are extremely rare in our coal measures. Other fragments which I have formerly referred to this genus are considered by Schimper as hairy or scaly rhizomas of Ferns.

Lycopodites pendulus, *Sp. nov.*, *Pl. LXII, Figs. 2, 2a.*

Stem small, flexuous, repetito-dichotomous; leaves linear-lanceolate, acuminate, inflated or convex on the back; nerve obsolete.

This plant is essentially different from a *Lepidodendron*, by the multiplied ramifications of branches, all of the same size, but of various length, flexuous, some of those of the third order appearing as if derived from the secondary divisions by innovations rather than by true dichotomy. In all the species of *Lepidodendron* which I have seen with narrow stem and slender branches, the divisions decrease always by the forking. In this species the branches are mostly of equal size. The leaves are loosely imbricated in spiral order, three to four millimeters long, lanceolate, acuminate, concave on the inside, without trace of nerve, but an indistinct medial inflation of the back.

Habitat—Shale of the Morris coal, Ill. Museum Comp. Zool., Cambridge, Ly. 11.

Lycopodites Meekii, *Lesqx.*, *Pl. LXII, Figs. 1, 1a.*

Lesqx., Geol. Rept. of Ill, IV, p. 426, Pl. XXVI, f. 6. Schp. Paleont., veget., III, p. 533.

Stems and branches very slender, dichotomous; leaves needle-shaped, very small, closely imbricated; medial nerve obsolete.

This species differs from the former by the very narrow and much smaller needle-shaped leaves, more closely imbricated. As in the former species the medial nerve is totally obsolete. The leaves are scarcely two millimeters long, and half a millimeter broad at the base which appears half embracing. I have seen only the fragment figured.

Habitat—Roof shale of the coal of Morris, Ill. Specimen in the State Cabinet of Illinois.

LYCOPODITES CAVIFOLIUS, *Lesqx.*

Geol. Rept. of Ky., IV, p. 437. Selaginites erassus, Lesqx., Geol. Rept. of Ill., II, p. 446, Pl. XXXIX, f. 8.

Stem apparently trailing, thick, irregularly dichotomous; branches short; leaves densely imbricate, concave, oblong or ovate, more or less distinctly acuminate, sometimes obtuse; nerve obsolete.

The species is comparable to *Lepidodendron Selaginoides*, as figured by Ll. & Hutt., Foss. fl., I, Pl. 12, and still more distinctly to *L.* (*Selaginites*) *Erdmanni*, Germ., Verst., p. 60, Pl. XXVI. Schimper refers this last species as figured by Gein., Verst., Pl. I, f. 5 and 6, to a rhizoma, under the name of *Rhizomopteris Lycopodioides*, Paleont. Veget., I, p. 699, remarking, however, that Geinitz's plant is far different from that of Germar. The leaves of the American plant are broader and shorter than represented in any of the above species, of a hard coriaceous texture, concave, as seen from the impressions upon the stone, four to five millimeters long, ovate, obtuse in the specimen of Illinois; sharply acuminate, even needle-pointed in that of Kentucky, which has them also less closely imbricate, and thus resembling those of *Lycopodites elongatus*, Gold. Fl. Saræp. foss., p. 11, Pl. I, f. 2. In both the nerve is totally obsolete. The characters are rather those of a *Lycopodites* than of a *Lepidodendron*. Probably the specimens represent two species. They are too small; it is not possible to see if the differences are permanent.

Habitat—Kentucky, shale of coal 1 B, near Racoon furnace, Ky.; Mazon creek, Ill., in nodules.

LYCOPODITES UNCINNATUS, *Lesqx.*

Selaginites uncinnatus, Lesqx., Geol. Rept. of Ill., II, p. 446, Pl. XLI, f. 3.

Rhizomopteris filiformis, Schp., Paleont., veget., I, p. 700.

Stem slender, dichotomous; upper branches pinnately divided nearly in right angle; branchlets more or less uncinnate; leaves needle form, acuminate, very narrow, in right angle to the stems.

Though it cannot be positively asserted that the fragment is referable to a *Lycopodium*, the upper branches opening in spiral and covered with leaves, prevent its reference to a rhizoma. The basilar or stem leaves are in right angle, seemingly variable in size, an appearance which may result from their position upon the branches; for some of them seem first emerging in acute angle, opening horizontally from above the base. In the upper branchlets the leaves are oblique and imbricate. I have compared this species to *Selaginites Erdmanni*, (Germ.,) as figured by Geinitz., l. c. But it is also comparable to Germar's figure of the same by the different position and size of the leaves, which are shorter, turned upwards and imbricate on the terminal branchlets.

Habitat—Colchester, Ill. Specimen in the State Cabinet.

LYCOPODITES ORTONI, *Sp. nov.*

Stem flattened, grooved in the middle; border leaves two ranked, lanceolate, acuminate, decurrent by the lower side, rounded on the upper, with intermediate rudimentary leaflets or scales; nerve obsolete.

This is a true *Lycopodium* represented by a single fragment of stem, two to three millimeters broad, four and a half centimeters long, forking in two branches of equal size and as long as the stem. Border leaves alternate, two ranked, half open, flat, six millimeters long, gradually taper pointed or lanceolate from the base, decurring and joined to the border of the stem on the lower side, rounded to the middle of the stem at the upper border, with very small intermediate coriaceous leaflets or scales, scarcely one millimeter long, triangular acute, placed in the middle of the flattened stem. The disposition of the leaves is in spiral order, similar to that of *Lycopodium complanatum*, L., with the difference that in this last species the intermediate leaves are as long as the lateral ones, and not mere scales, as in the fossil plant, whose leaves are also more open. The species is closely allied to *L. macrophyllus*, Gold., Fl. Sarræp. foss., I, p. 12, Pl. 1, f. 5b.

As it is generally the case in leaves ot fossil plants of this genus, the medial nerve is obsolete.

Habitat—Shale above coal (No. VI), Shawnee, Perry county, Ohio. Cabinet of Prof. Ed. Orton.

LYCOPODITES STRICTUS, *Sp. nov.*

Stem straight, cylindrical; leaves closely imbricated in spiral order and linear-lanceolate, acute; top branches slender, inclined downwards, bearing spikes, organs of fructifications.

The stem is eight millimeters broad, flattened, of equal size in its whole length, eighteen to twenty centimeters long, with closely appressed imbricate leaves, about eight millimeters long, inflated on the back, and coriaceous. It bears at its top three spikes, at the end of slender nearly pending or curved down pedicels, four millimeters broad, three centimeters long, evidently organs of fructifications. They are covered with much shorter half open leaves or scales, with pulverulent glomercules in the axils, as far at least as it can be seen.

Habitat—I have found the specimen in the roof shale of a coal bed near New Harmony, Ind., (upper coal), with fragments of other plants, shells, and scales of fish. Though the specimen evidently represents a *Lycopodium*, the spikes somewhat crushed are too obscure for satisfactory description. It is Ly. 4, of the Museum of Comp. Zool. Cambridge, Mass.

SPECIES OF UNCERTAIN RELATION.

LYCOPODITES ANNULARIÆFOLIUS, *Lesqx.*

Geol. Rept. of Ill., IV, p. 426, Pl. XXI, f. 5.

Stem round, dichotomous; leaves irregularly disposed, some single on each side, alternate, others apparently joined by two at their base, open, lanceolate, slightly narrowed at the decurrent base, obtusely pointed, comparatively large and distinctly nerved.

This fragment has no relation, known to me, to any plant of the coal. The leaves are nearly three centimeters long and three millimeters broad in the middle, resembling leaves of *Annularia*, but somewhat narrower toward the base, more obtuse at the apex and decurring by the lower margin to the round stem, which bears only one short branch by an axillary division like that of a dicotyledonous plant. The leaves are distinctly nerved and very irregular in their disposition, which, though, is not plainly recognizable, as the specimen is crushed and the leaves mostly destroyed on one side. Except some short lines marked lengthwise on its surface, the stem has no trace of scars and nothing upon it to point out a spiral arrangement of the leaves. Therefore, though the mode of branching may be comparable to that of some *Lycopodiaceæ* of our time, the *Ruelliæ*, the relation of this branch to *Lycopodites* is scarcely acceptable. The leaves resemble those of *Walchia flaccida*, as represented in Goepp. Perm., fl., Pl. L, f. 2. *Ullmannia biarmica*, Eichw., seems, from the figure of the species in Goepp., l. c., Pl. LII, f. 2, to have a branch disposed as that of this species; hence we may have here a fragment of a Conifer. It would be the first of that class seen in our lower coal measures.

Supposing that my first examination of this remarkable plant might have been inaccurate in some points, the specimen was again kindly sent me for a revision of its characters. But I could find nothing new. The figure is perfectly exact in every part, the leaves only being a little less narrowed near the base than they appear upon the fossil fragment.

Habitat—Nodules of Mazon creek; specimen in the cabinet of Prof. A. H. Worthen, Warsaw, Ill.

LYCOPODITES RICHARDSONI, *Daws.*

Devon. Plants of N. E. Am., Quat. Journ. Geol. Soc., May, 1863, p. 461, Pl. XVII, f. 1, 2.

Stems slender, tortuous, dichotomous; barren branches with short erect or recurved leaves, apparently in two ranks; fertile branches lateral, one sided, in the form of sessile strobiles.

I have found what I believe to be the same plant in the red shale just above the Chemung, near Trevorton, Penn'a. The specimen is obscure, and seems to represent a Fern, the lateral branches being marked with a large medial nerve like a rachis, bordered with a lobed lamina, like pinnæ of *Pecopteris*. The same appearance is seen f. 1, l. c.

Habitat—Perry, Maine; an obscure species.

LYCOPODITES COMOSUS, *Daws.*

Dev. Plants, l. c., p. 462, Pl. XVII, f. 14.

Stem short, not observed to branch, densely covered with filiform leaves.

A mere bud, one and a half centimeters long, with an obscure axis bearing apparently half open filiform and flexuous leaves. The whole is indistinct. It is comparable to a small fragment of the top of a branch of *Lycopodites* (*Rhizomopteris*) *selaginoides*, as figured in Gein., Verst., Pl. I. f. 2.

Habitat—Same locality as the former.

LYCOPODITES VANUXEMI, *Daws.*

Dev. Pl., l. c., 1862, p. 314, Pl. XVII, f. 57. Hall's Rept. on the Geol. of New York, p. 273, f. 125. Vanuxem, ibid., p. 175, f. 46.

Stem slender; leaves pinnate, contiguous, linear, one to one and a half centimeters in length.

The plants, says the author, are graceful feathered stems, apparently growing in groups.

This species seems very closely allied to *L. pennæformis*, Goepp. Uebergsg. Fl., p. 508, Pl. XLII, f. 2. Still, says the author it is very doubtful if it was a Lycopodiaceous plant. Schimper, mentioning the species, supposes that it may represent a leaflet of Fern deprived of the epidermis. It may be an Encrinite?

Habitat—Chemung group of New York, near Ithaca, Jas. Hall. Waverly sandstone of Perry county, Ohio, Prof. E. B. Andrews.

LEPIDODENDRON.

Surface of the stem, marked by peculiar scars, points of attachment of the leaves; leaf scars (bolsters) rhomboidal-oblong upon the bark of large trees, or merely rhomboidal upon the small branches, very variable in size according to their position, enlarging comparatively to the growth of the stems, often disfigured by dilation of the bark; central cicatrices (inside scars) rhomboidal, transversely dotted by three points (vascular scars), bearing generally, under the lower margin, two oval small tubercles, scars of bundles of vessels (appendages) placed on each side of a medial line (cauda), which, like the appendages, is more or less distinct, sometimes deep and wrinkled across, sometimes obsolete.

The characters of the fructifications, the relative position of the leaves, and the mode of division of the stems are those of the *Lycopodiaceæ*. The spikes or cones of the fructifications are described under the generic name of *Lepidostrobus*, the blades of their sporanges as *Lepidophyllum*.

The species of this genus are difficult to determine, for the specific characters are mostly derived from the scars, left upon the branches at the point of attachment of the deciduous leaves, scars generally observable by counter impressions upon hard materials, shale or sandstone. The leaves were persistent only upon small branches; therefore, the fragments bearing leaves have the scars very small, generally crowded and more or less indistinct, while upon the larger branches or upon trunks, the cicatrices are modified, in size at least, by the age of the trees, or upon their different parts, by casual alterations in the process of their growth. It has been, therefore, often contended that the determination of fragments of *Lepidodendron* was very unreliable, and that most of the authors had too widely and without sufficient reason, increased the number of species of this genus.* I do not wish to enter into a discussion on the matter. All the so-called species established upon specimens of fossil plants are more or less unreliable and subject to criticism. What I have said in regard to the determination of the Ferns is equally applicable to that of the fragments of *Lepidodendron*, *Sigillaria*, etc. The variations of the scars, in *Lepidodendron* at least, is mostly depending from the enlargement of the bolsters by age. They are often crushed and defaced by compression or abrasions, especially towards the base of the trunks, as all the fossil vegetable remains are more or less defaced by maceration, compression, etc. In *Sigillaria* the scars are generally of a different character, under every successive layer of the bark. In *Lepidodendron* the character of the bolsters, preserved against abrasion, are often recognizable upon the whole length of large trunks.† In any case, I have endeavored to fix the species of this genus from the examination of as large a number of specimens as I was able to obtain

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*In America; H. L. Fairchild, on the variations of the decorticated leaf scars. New York Acad. Sci., v. 1, No. 2. Same subject, ibid, No. 3. On the identity of supposed species of *Sigillaria*. Ibid, No. 5.

† On this subject, Phytopaleontologists may examine, with interest, a remarkable deposit of a large number of trunks of *Lepidodendron*, with some *Stigmaria* and *Sigillaria* on the sandstone forming the bed of Little Beaver river, on the limits of Ohio and Pennsylvania. The trees have left the impressions of their stems only upon sandstone; they have no branches, and all the woody matter is destroyed. These impressions are generally distinctly preserved, though the sandstone bottom of the river has been washed by an indefinite period of time. Probably the vegetable remains were heaped and successively imbedded in the sand, and are now gradually laid out and their successive layers exposed by the disintegration of the stone. I visited the falls in 1878, and there saw trunks of *Lepidodendron*, or rather their deeply concave impressions exposed, measuring fifty to sixty feet long, (sixteen to eighteen meters,) forty to fifty centimeters in diameter. The leaf scars, when distinct in the whole length, show identical characters with scarcely any deviation of the specific type.

for comparison. And I have also taken into consideration the specimens bearing leaves and represented them as often as their characters were clearly defined. The descriptions apply equally to the impressions and the outside surface of the scars.

Little is known yet of the internal structure of *Lepidodenbron.* A species, *L. Harcourti*, has been described by Brongniart from microscopical analysis of silicified specimens in comparison with *Sigillaria* and *Stigmaria.* Arch. dú. Museum, d' Hist. Nat., I, 1839. The characters of this species have an affinity to those of some Lycopods of the present epoch, *Psilotum* and *Tmesipteris.* Another species, *L. vasculare*, has the structure of *Sigillaria.*

The roots of these large trees also, are not positively known. Some authors regard the *Stigmaria* as roots of *Sigillaria* and *Lepidodendron.* As the plants of these two families are different in their internal structure and now referred by a number of authors, the ones to *Lycopodiaceæ*, the others to phœnogamous gymnosperms, *Stigmaria* is not likely to represent the roots of two groups of vegetables widely separated by the structure of their stems. In some localities where remains of *Lepidodendròn* are abundant and where species of this genus constitute the essential compounds of the coal, I have found, in the shale, small stems of *Lepidodendron* all of the same size with very short divisions, short leaves and branches crowded upon each others in every direction, seemingly creeping, and thus apparently rhizomas of species of this genus. This however is merely hypothetical; for I have never seen a trunk of *Lepidodendron* preserved standing with roots attached to it, and no case of that kind has been observed by phytopaleontologists.

The leaves of *Lepidodendron* though variable, especially in length, generally preserve their specific characters. They have a medial nerve, formed of parallel bundles of vessels which, in large leaves, become separated and more or less distant. The leaves therefore appear doubly or triply nerved as in Atl., Pl. LXIII, f. 8.

The age of the *Lepidodendron* coincidates with that of the more productive part of the carboniferous. Few species are recorded from the Devonian; most of them, as also the largest representatives of the genus, are found with the conglomerate measures, at a short distance below and above them. Their remains have been very rarely found at the horizon of the Pittsburg coal. Goeppert, however, describes three species from the Permian. Among them, remarkably enough, *L. Veltheimianum*, generally considered as a leading plant of the lower or subconglomerate Coal measures. It is however there represented especially by *Knorria*, eleven species of which are quoted by the author as its synonyms. We have here evidently one of those cases of confusion upon which I have remarked already. Another of these Permian species is *L. anceps*, also a *Knorria* of uncertain character. The third *Lepidodendron formosum*, is, from the characters exposed in the figure of the author, a true *Sigillaria*.

The separation of *Lepidodendron* into different genera has been attempted by some authors, among others by Sternberg and Goldenberg. The last, in Fl. Sarræp., I, p. 16, fixes the characters of *Lepidodendron*, *Sagenaria*, *Aspidiaria* and *Bergeria* from the relative position of the bolsters and the mode of attachment of the leaves, either on the top or on the middle of the cicatrices. These characters being unreliable, this classification has not been admitted by any recent Phyto-paleontologist.

All the following species are described from American specimens.

Species known with stems, leaves and fructifications.

LEPIDODENDRON STERNBERGII, *Brgt., Prodr.*

L. lycopodicides, St., Fl. d. Vorw., 1, p. 26, Pl. XVI, f. 1, 2, 4.
L. gracile, Ll. & Hutt., Foss. fl., I, Pl. IX.
L. elegans, Ll. & Hutt., ibid., II, Pl. CXVIII.
L. selaginoides, Ll. & Hutt., I, Pl. XII.

Branches long and slender, flexuous; leaves coriaceous, small, narrowly lanceolate from a slightly enlarged base, gradually acuminate. half open and more or less incurved *from the middle; medial nerve thick; borders reflexed; bolsters rhomboidal-oval upon the branches, exactly rhomboidal and equally narrowed at both ends upon the old stems, with an obscure triangular protuberance seen at the top upon slender branches; cones small, cylindrical, obtuse; sporanges short, cuneiform; bracts closely appressed and imbricate, lanceolate, acute.*

The numerous fragments representing this species are all upon the same kind of shale and have been obtained from the same place. Related as they are by their characters, they represent evidently the same species. The branches one millimeter broad, are flattened, comparatively long and sparingly forking; the leaves closely imbricated are only five to seven millimeters long and one millimeter broad, toward the slightly enlarged base. The strobiles are all exactly cylindrical, obtuse, two and a half to four centimeters long, one centimeter in diameter, with bracts of the same length as the leaves but a little broader and lanceolate or gradually narrowed from the base to an acute point. A single one of the strobiles, disconnected from any stem, is much larger, twelve centimeters, two centimeters in diameter, with bracts of the same character as those of the small ones, also exactly cylindrical in shape. It may have been depending from a stronger branch. The bolsters as seen upon older branches or upon trunks, and described above, have the same characters as those of *L. elegans*, Ll. and Hutt., l. c. When covered by the coaly epidermis, which, in large stems, is nearly half a millimeter thick, the bolsters are merely convex without any traces of inside scars, except a round point in the middle, just like those of *L. Selaginoides*, Ll. and Hutt., l. c. When decorticated, the large bolsters twenty-two millimeters long, one millimeter broad, narrowly rhomboidal, have under the apex a small triangular inflation with a more distinct central point or mammilla.

By the form and character of the bolsters, this species corresponds with the description of *L. selaginoides*, St., in Schp., Paleont. veget., II, p. 31, while by the characters of the leaves and cones it represents a diminutive form of the species quoted above as synonyms of *L. Sternbergii*. But all the other forms, a large number, among them *L. dichotomum*, which are also referred as synonyms to the same *L. Sternbergii* by Shimper and Geinitz, have their bolsters either square or broadly oval, narrowly acuminate at both ends, clearly marked with an inside transversly rhomboidal scar, already distinct at the base of the leaves of small branches. Hence the American specimens referable by their characters to *L. Sternbergii*, as indicated by the synonymy which I have admitted, positively differ from *L. dichotomum* and other allied forms which I mention with the description of this last species.

These specimens which come from the subconglomerate coal, differ somewhat in the size of the branches, leaves and cones, from *L. Sternbergii* as described by St. and Ll. and Hutt. The differences are not wide enough to authorize a specific distinction.

Habitat—Black Creek Coal, Ala. Communicated in numerous specimens by Mr. Thos. Sharp, superintendent of the New Castle Coal Co.

Species known with branches and leaves.

LEPIDODENDRON BRITTSII, *Sp. nov., Pl. LXIII, Figs. 1–2.*

Branches of medium size, rigid; leaves open, lanceolate; bolsters, transversely rugose, rhomboidal-oval, narrowed and acuminate at both ends; inside scars central, transversely oval, the upper line slightly emarginate in the middle and mucronate, the lower half round; appendages obsolete.

The leaves, half open, sometimes turned down as in the large fragment of f. 2, are one and one half to three centimeters long, largest at the point of attachment, two to four millimeters broad, gradually narrowed to a sharp acumen, with a thin though distinct medial nerve.

Typically allied to *L. Volkmannianum*, St.

Habitat—Clinton coal, Mo., Dr. J. H. Britts.

LEPIDODENDRON LANCEOLATUM, *Sp. nov.*, *Pl. LXIII, Figs. 3–5a.*

Branches of medium size; leaves open or in right angle to the stems, a little curved up toward the apex, lanceolate, acute, slightly broader in the middle; scars narrowly obovate or oblanceolate, open at the base, emarginate and topped with a small round mammilla; surface smooth; cauda deeply marked, not wrinkled.

The leaves are short, comparatively to their width, one and one half centimeters long, and nearly three millimeters broad in the middle. The young bolsters, f. 3 and 5, narrowly obovate, are separated by narrow borders which do not connect at the base. The inside scar as seen before its full development is narrowly rhomboidal, the round mammilla at its top indicating its point, when older.

The species is related to *L. marginatum*, Presl., differing especially by the inside scar placed lower down on the bolsters. In old specimens, the bolsters become narrower, more elongated, nearly continuous, appearing like ribs of *Calamites*.

Habitat—Clinton Coal, Dr. J. H. Britts.

LEPIDODENDRON SCUTATUM, *Sp. nov.*, *Pl. LXIII, Figs. 6–6c.*

Stems of small size; leaves short and narrow, linear, acuminate, open from the base, curved up toward the apex, or in right angle to the stems; medial nerve obsolete; bolsters oval, narrowed and acuminate at both ends; inside scars round, placed near the apex, with a central round point.

I should have considered this species the same as the former, but for the short and very narrow leaves, seven to ten millimeters long, scarcely one millimeter broad, nearly linear, more sharply acuminate and without a visible medial nerve. In my specimens, the inside scar is not fully developed; outlined as rhomboidal in shape, it is placed at the top of the bolsters, f. 6*b*, as in *L. vestitum*, Atl., Pl. LXIV, f. 15, which may represent the same species.

I refer to this a small specimen from Cannelton, described in manuscript as *L. setifolium.* It differs only by the quite smooth surface of the bolsters.

Habitat—Clinton Coal, Dr. J. H. Britts.

LEPIDODENDRON LATIFOLIUM, *Sp. nov., Pl. LXIII, Figs. 7–8.*

L. salebrosum? Wood, Trans. Amer. Phil. Soc., XIII, p. 345, Pl. VIII, f. 6.

Fragment of a cylindrical stem flattened by compression; leaves large, three nerved; bolsters exactly rhomboidal, with equal parallel margined sides; inside scars at the top, same form as the bolsters; vascular points distinct; appendages none; cauda marked by wrinkles only.

This fragment, not an impression, but the cross section of a whole stem, is a very fine one, remarkable by the distinctness of the convex bolsters, the position of the inside scars and the width of the leaves, at least seven millimeters broad, probably very long. They are really three nerved, with an inflation between the border lines. I do not know of any form to which this species may be compared. *L. salebrosum*, Wood, loc. cit., seems to represent it in its decorticated state.

Habitat—The specimen was presented to me twenty years ago by Mr. Ed. Jones, supt. of the coal mines at Oliphant, Pa. It comes from that locality but the reference to the horizon of the coal is not indicated. It is in the collection of the Museum of Comp. Zool., Cambridge; Check L. 20.

LEPIDODENDRON MORRISIANUM, *Lesqx.*

Geol. Rept. of Ill., IV, p. 430, Pl. XXII, f. 1, 2.

Stem large; supercortical bolsters indistinct in outline; inside scars transversely rhomboidal and angular, more enlarged on the sides; vascular scars distinct; sub-cortical bolsters tumescent, rhomboidal, acute on the more enlarged sides, rounded at the top and the base, marked by three large distinct vascular points, without inside scars; leaves long and narrow, three nerved.

The fragment is not easily analysed, on account of its double representation. On the left side, the corticated surface is marked with inside scars bearing leaves ; on the right the under surface is seen, with the bolsters upraised, as born upon an inflated base representing apparently, in a different shape, both the bolsters and the inside scars seen upon the bark. The leaves are at least thirty centimeters long, five and half millimeters broad, crowded, forming by compression a thick layer upon the surface. They have the same kind of nervation as those of the former species. a thin medial nerve, with a broad border on each side.

Habitat—Shale of the coal of Morris, Ill. Communicated by Mr. Jos. Even.

LEPIDODENDRON ACULEATUM, *Sternb.—Pl. LXIV, Fig. 1.*

St., Flor. d. Vorw., 1, p. 23, Pl. VI, f. 2. Lesqx., Geol. of Penn'a, 1858, p. 874. Schp., Paleont. Veget., II, p. 20, Pl. LIX, f. 3 ; LX, f. 1, 2, 6.

Sagenaria aculeata, Presl., in St., Fl. d. Vorw., II, p. 177, Pl. LXVIII, f. 3.

S. caudata, St., ibid., p. 178, Pl. LXVIII, f. 7.

Lepidodendron undulatum, St., loc. cit., 1, p. 21, Pl. X, f. 2, (decort.)

Aspidiaria undulata, St., ibid., II, p. 182, Pl. LXVIII, f. 13, (decort.)

Lepidodendron appendiculatum, St., ibid, 1, p. 38, Pl. XXVIII.

L. ingens, Wood, Proc. Acad. Nat. Sci., Phil., June, 1860, p. 239, Pl. VI, f. 4.

L. Lesquereuxii, Wood, ibid., p. 240, Pl. V, f. 4.

L. ureum? Wood, Trans. Am. Phil. Soc., XIII, p. 343, Pl. IX, f. 5.

Bolsters large, rhomboidal-ovate or spindle-shaped, narrowed, elongated and curving at both ends in opposite direction; inside scars a little above the middle, rhomboidal-ovate, obtuse at the top, enlarging to the narrowed and slightly obtuse sides, decurring in an acumen to the cauda, and small comparatively to the bolsters; appendages distinct, cauda wrinkled across; leaves very long, narrow, in right angle to the stems, channeled by a broad medial nerve.

This species, says Schimper, is generally found with *L. obovatum.* He supposes that it may be a variety of it, merely distinct by its narrower bolsters, more elongated and acuminate at both ends. From the characters of the American specimens, which I consider its representatives, it is evidently different. The inside scars are nearly central, more elongated, narrower, not half round, but only obtuse at the upper border. The leaves are narrow, two and a half millimeters broad, distinctly channeled by the broad nerve, and very long, at least sixteen centimeters, disposed in right angle to the stem. The bolsters, though still bearing leaves, are large, already two centimeters long, eight millimeters broad, and therefore the persistence of the leaves may be considered as a specific character.

Habitat—The species is not rare in the anthracite measures of Penn'a.—Minersville, Summit-Lehigh, Carbondale. From the last locality is the specimen L. 99, of the Museum of Comp. Zool. Cambridge, with leaves partly broken. Another, L. 119, is from Newport, Rhode Island, with leaves preserved longer, but nevertheless not in their integrity. A single specimen, L. 118 of the same collection, in nodules from Mazon creek, and with the surface decorticated, represents *L.* (*Sagenaria*) *caudatum*, St. l. c.

LEPIDODENDRON RIGENS, *Lesqx.*

Geol. Rept. of Ill., IV, p. 429, Pl. XXVII, f. 1–3.
L. dichotomum, Roehl, Foss. fl., Paleont., XVIII, p. 125, Pl. XI, f. 2.

Top branches with long rigid inflated sub-cylindrical leaves; bolsters upraised, rhomboidal, laterally enlarged; inside scars of the same form, shorter, covering the upper half of the bolsters.

The fragment described is from the nodules of Mazon creek, and has preserved its original characters without any deformation by compression or maceration. It shows the bolsters much inflated, the point and mode of attachment of the leaves around the inside or leaf scar, and the bundles of vessels passing up into the leaves. It also represents the leaves to be half round, even in the upper part, as seen from detached fragments, more than twenty centimeters long, three millimeters in diameter, gradually acuminate, grooved lengthwise by a narrow flat channel tracing the direction of the vessels. Another specimen of the same species has the leaves flattened by maceration, with their epidermis transformed into a thick coating of coaly matter.

Channeled on one side, obtusely keeled on the other, the groove is marked on each side by a distinct line, and none is seen in the middle, the medial bundle being immersed into the substance of the leaves.

Roehl, l. c., has figured a splendid specimen from a much larger branch than those I had for examination. The upraised scars, the inflated leaves very rigid, all the characters, indeed, are identical with those described above. He refers this branch to *L. dichotomum*, St., which, as it will be seen in the description of this species, has short lanceolate flat leaves, in no way comparable to those of our plant.

Habitat—Mazon creek, in nodules; Mr. S. S. Strong.

LEPIDODENDRON LONGIFOLIUM, *Brgt.*, *Prodr.*

L. dichotomum, St., Fl. d. Vorw., I, p. 23, Pl. III. Ll. and Hutt., Foss. fl., III, Pl. CLXI. Schp., Paleont. Veget., II, p. 22.

L. Sternbergii, Ett., Fl. v. Radnitz, p. 54, Pl. XXVI, f. 1, 2. Pl. XXVII and XXVIII.

Scars of the branchlets similar to those of L. dichotomum; leaves very long and narrow, crowded in tufts at the top of the branches.

The specimen shows only the top of a branch, the scars being covered by the leaves are not distinct. Their characters are taken from the description of this species in Schimper, l. c. The leaves are very narrow, scarcely two thirds of a millimeter broad at the base, pressed upon another, crowded in tufts, straight and rigid, twelve to sixteen centimeters long or more, with a deep medial nerve and borders reflexed. Except that the branch is smaller, the specimen is perfectly similar to that represented by Lindley and Hutton, l. c. Sternberg considers the fragment figured in his work, l. c., as a young individual of *L. dichotomum.* The specimen described here is the top of a young branch. In *L. dichotomum*, all the fragments of the same kind bear short leaves. The similarity of the scars upon large trunks merely proves that old scars of *Lepidodendron* of different species may be alike, and that, therefore, a confusion of species established from the bolsters of this genus is quite as possible or frequent as a specific multiplication caused by variations upon the same stems.

Habitat—The specimen is in the cabinet of Mr. R. D Lacoe, of Pittston, Penn'a, from Brown colliery, E vein. It is the only one I have seen of this species in the American coal measures.

LEPIDODENDRON VELTHEIMIANUM, *St. Pl. LXII, Figs. 6–8.*

St., Fl. d. Vorw., I, p. 12, Pl. LII, f. 3. Roehl, foss. fl., p. 130, Pl. VIII, f. 3; Pl. XXIII, f. 5. Lesqx., Geol. Rept. of Ill., II, p. 455. Schp., Paleont. veget., II, p. 29. Stur, Culm. fl., p. 269, Pl. XVIII, f. 2, 3; Pl. XIX, f. 5, 6, 8, 9, 10; Pl. XX, f. 1–6; Pl. XXI; XXII, f. 1–3. Heer, Fl. d. Bären Insel, p. 38, Pl. VIII, f. 1–7; Pl. IX, f. 2–4.

L. giganteum, Lesqx., Boston Journ. S. N. H., v. VI, p. 429. Geol. of Penn'a, 1858, p. 874, Pl. XV, f. 2.

L. Greenii? Lesqx., Geol. Rept. of Ill., IV, p. 433, Pl. XXVII, f. 7–8.

L. mammillatum, Lesqx., ibid., p. 432, Pl. XXV, f. 1.

Sagenaria Veltheimiana, Presl., in St., l. c., II, p. 180, Pl. LXVIII, f. 14. Goepp., Fl. d. Uebergsg, p. 180, Pl. XVII–XX; XXIII, f. 1–3; XXIV, f. 2, 3; XLIII, f. 1. Koechl., Schlumb, and Schp., Terr. trans. d. Vosges, p. 336, Pl. XXI–XXVI.

S. elliptica, Goepp., l. c., p. 184, Pl. XLIII, f. 7.

S. acuminata, Goepp., ibid., p. 185, Pl. XXIII, f. 4; Pl. XLIII, f. 8–10.

*Phytholithus cancellatus, Steinhauer, Trans. Am. Phil. soc., I, p. 280, Pl. VI, f. 2–6.**

Trunk large; leaves linear-lanceolate, small, slightly narrowed near the base, half open; bolsters rhomboidal, oblong or spindle-shaped, acuminate to both ends; inside scars in the middle of the bolsters, transversely rhomboidal, more acute at the sides, highly convex; appendages rarely distinct; cauda deep smooth or wrinkled.

The characters of the bolsters and scars of this species are extremely difficult to fix, on account of their great diversity according to the age or the size of the trunks and branches, and to the presence or absence of the cortex and of the epidermis. The above description is made from the representation in Stur., l. c., Pl. XIX, f. 5, 6. I have seen in Mr. D. R. Lacoe's cabinet, a number of finely preserved specimens, which, corticated, have the bolsters in elongated lozenge-form, with the prominent inside scar rhomboidal, acute on the sides, the top and base obtuse, distinctly marked near the base by the three vascular points, with a deep furrow, passing from the top of the scar to that of the bolsters and continued downward by a deep, slightly wrinkled cauda. In a decorticated state, this furrow is generally preserved with the central scar either round or rhomboidal, as in Atl., f. 6. Under different circumstances, the medial scars become oval, surrounded by an oval base, which follows the borders and curve around it or is joined under it, as in Atl., f. 7. This last configuration is however very rare. Heer refers the fragment which represents it under the name of *L. commutatum*, Schp., l. c., p. 39, Pl. VII, f. 8–10, to *Ulodendron commutatum*, Schp., a species figured Atl., Pl. LXVI, f. 2. I do not consider this reference as right; for in that *Ulodendron* the oval scars have a central point surrounded by a ring, while in the decorticated young specimens of *L. Veltheimianum*, the oval bolsters are either topped by an upraised rhomboidal acute impression, as in Atl., f. 7, and also in those figured by Heer, l. c., while in older decorticated stems, when left without top scars, the bolsters are longitudinally traversed by a narrow ridge. I must, however, say that f. 6 and 7 of Atl., which I described as *L. Greenii*, l. c., and which represent a mere fragment of a large slab, are as yet unique, and cannot be positively compared to any other representative of a *Lepidodendron*. The reference of the specimen, therefore, to *L. Veltheimianum*, is merely presumable from its likeness to the decorticated bolsters of this species, which are sometimes oval, and from its subconglomerate habitat. In *L. Veltheimianum*, the bolsters are always contiguous before decortication; this character does not agree with the great distance of the scars, as marked f. 7.

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* A large number of other synonyms are referred by authors to this species among others *L. chemungense*, Hall and a dozen *Knorria* by Goeppert. I quote only the more important.

There is in the cabinet of Princeton college, New Jersey, a specimen which I refer to the same species, and which has the bolsters oval, topped by a small rhomboidal scar bearing a single point in the middle. The bolsters are only one centimeter long, including the leaf scar at the top, four millimeters broad, and two and a half centimeters distant in the oblique direction of the scars. This indicates a greater separation of the bolsters than it is generally observed. This form, like that of Atl., f. 7, may represent *L. Wickianum*, Heer, l. c., whose scars, though small, are sometimes very distant.

Other specimens in the cabinet of Prof. E. B. Andrews bear broadly oval scars, five millimeters long, four broad, convex, marked at the top by a small mammilla, like those mentioned from Princeton. They are more than seven millimeters distant, sometimes irregular in their relative position, as in *L. Wickianum*, but separated by longitudinal wrinkles which mark the outlines of continuous borders of the effaced bolsters. Then, it seems, these specimens may be considered as representing still a variety of this polymorphous species. F. 6, Atl., is from a specimen of Alabama.

It is probable that the branches and leaves described as *Lycopodites asterophyllitæfolius*, Lesqx., Geol. Rept. of Ill., II, p. 447, Pl. XXXVII, f. 3, are referable to this species.

Habitat — Mostly found in the subconglomerate coal measures. The specimen of f. 7 is from Mercer county, subcarboniferous measures of Illinois; common in the Alabama coal field; Helena mines. The specimen f. 6 and a number of others of the same character, are in the cabinet of Mr. R. D. Lacoe, from Campbell's Ledge, subconglomerate, and also from Seneca and Boston vein, Pittston. Those of Prof. E. B. Andrews come from the shaft of Jackson coal, Ohio. Sub or intra conglomerate.

LEPIDODENDRON SQUAMIFERUM, *Sp. nov. Pl. LXII, Figs. 3–3d.*

Stems slender, bearing loosely imbricated linear-lanceolate acuminate leaves, with broadly rhomboidal or round mucronate scales intermediate to their point of attachment.

The figure represents all what is known of these peculiar vegetable remains, which might possibly be referable to *Lycopodites*.

The scales appear to have covered all the stem, placed like the leaves in spiral order, their base being close to that of the leaves, or even covering it. These scales, as seen f. 3, are somewhat thick, or inflated in the middle to half a milimeter. They are easily detached from the stem, even off from it in many places where their impressions remain distinct. They are two millimeters in diameter, nearly round or broadly rhomboidal, slightly mucronate, as seen f. 3*b*–3*d*, marked in the middle by a longitudinal inflated line passing from the sometimes emarginate or mucronate top to the base.

No plant from the coal measures has any relation to this. The leaves are much narrower than those of *L. Veltheimianum*. The scars of the leaves are indistinct, as effaced by the superposition of the scales which leave concave impressions of exactly the same shape.

Habitat—Helena coal mines; communicated by Prof. Eug. A. Smith. Specimen No. 18 of the State Cabinet of Alabama.

LEPIDODENDRON PRIMÆVE, *H. D. Rogers*.

Geol. of Penn'a, 1858, II, p. 828, f. 675. Schp., Paleont. Veget., II, p. 36.

Bolsters fusiform, marginate, umbonate, confluent at their ends; leaf scars obsolete.

The figure represents a fragment of a dichotomous stem with bolsters, as described above, bearing at the top a fascicle of leaves larger than they are generally seen in this genus, smooth or lineate, without distinct middle nerve. The specimen appear decorticated, and the leaves are obscurely delineated.

Habitat—Near Huntingdon, Penn'a, from the Devonian Marcellus epoch. I have found at the same locality a quantity of fragments of *Lepidodendron leaves* normal in their characters, long, linear, canaliculate and nerved.

LEPIDODENDRON CORRUGATUM, *Daws*.

Geol. surv. of Canada, 1873, p. 19, Pl. II, III, IV, V, f. 33–36 and 38.
Stigmaria minuta, Lesqx., Geol. of Penn'a, 1858, p. 871, Pl. XVI, f. 1, 2.
Lepidodendron scobiniforme, Meek, Appendix Bull. Phil. Soc., Wash., (1875), p. 13, Pl. I, f. 1.

Branches slender; leaves linear-lanceolate, acuminate; bolsters close, contiguous at base, laterally more or less distant, ovate, acute at both ends; inside scars placed above the middle, small, rhomboidal or punctiform. In the decorticated state the bolsters are grooved convex or carinate in the middle.

Prof. Dawson gives, l. c., a very detailed account of his species, describing and figuring the very variable characters of the fragments which represent it. The bolsters vary in length from five to twelve millimeters and from two to four in width.

Schimper compares to it *L. Veltheimianum*, St. The relation though marked, by the form especially of the decorticated bolsters, is however distant, on account of their comparatively small size and of their small inside scars. The figure of a separate bolster, Pl. II, f. 13*a*, l. c., is about exactly the same as that of *L. lanceolatum*, Atl., Pl. LXIII, f. 5. Prof. Dawson's species is however distinct by the characters of its leaves, the form and central position of the inside decorticated scars, etc. I refer to this species the fragment f. 2, of the Geol. of Penn'a, l. c., which represents the stem of a *Stigmaria* constantly found in connection with it. The areoles or bolsters at first round, very small, with a central vascular scar as in *Stigmaria*, become, upon the stem, oval, narrowed to the base and marked from the top to the middle by a dividing short furrow. It represents f. 15 and 29 of Daws., l. c. I refer also to the same species *L. scobiniforme*, Meek., which has the inside scars at the top of the areoles and these contiguous at the base corresponding to Dawson's f. 27 and 36. The description of Prof. Meek is very clear and refers to the divers forms of this species including *Stigmaria minuta*, Lesqx.

Habitat—Specimens from the Chemung or Hamilton group of Akron, Ohio, are in Prof. Hall's collection, according to Prof. Dawson's remarks. The species is extremely variable and common in the red shale at the base of the Carboniferous of Penn'a, near Pottsville. Also in Virginia, Lewis Tunnel. Prof. F. B. Meek.

SPECIES DESCRIBED FROM BOLSTERS AND SCARS ONLY.

§ 1. *Inside scars at the top of the bolsters.*

LEPIDODENDRON VESTITUM, *Lesqx., Pl. LXIV, Fig. 15.*

Boston Jour. S. N. H., v. VI, p. 428. Geol. of Penn'a, 1858, p. 874, Pl. XVI, f. 3. Schp., Paleont. Veget., II, p. 26.

L. sigillarioides, Lesqx., ibid., p. 875, P.. XV, f. 6.

L. Oweni, Wood, Proceed. Acad. Nat. Sci., Phil'a, p. 239, Pl. V, f. 1 (1860.)

Bolsters rhomboidal, elongated, angular, narrowly margined; inside scars at the top, rhomboidal-acute; appendages and vascular points generally obsolete; cauda deeply wrinkled.

The upraised borders of the bolsters are often flattened by compression upon the inside scar and cover it in part. The bolsters are generally larger than in the specimen figured, the marginal inflation broader.* The scars seem to represent, on an enlarged scale, those of *L. scutatum*, Pl. LXIII, f. 6–6*c*.

L. sigillarioides, Lesqx., l. c., is from a decorticated specimen which may be referable to this species or to *L. latifolium.* The bolsters are exactly rhomboidal, eight millimeters long, six broad, the inside scars at the top, enlarged and acute on the sides, obtuse at the upper and lower border, have three indistinct vascular points and no trace of appendages nor of a cauda.

Habitat—Rare in the coal measures. Wilkesbarre and Archibald B & C vein. Nodules of Mazon Creek. The specimen from which *L. sigillarioides* was described is from Summit Lehigh.

LEPIDODENDRON RUSHVILLENSE, *Andrews.*

Geol. Rept. of Ohio, Paleont., II, p. 423, Pl. LIII, f. 4.

Bolsters broadly rhomboidal, symmetrical; leaf scars quite near the upper borders, rhomboidal, enlarged laterally, topped by a small oval mamilla; middle vascular scars large and distinct, the lateral ones small and obsolete; cauda and appendages distinct.

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* As most of the specimens represented in the Atlas are merely casts, the parts described as inflations or tumescences correspond to furrows or concavities of the bark in its natural state.

The description and figure, l. c., were made from a young or half decorticated specimen which does not represent exactly the characters. The bolsters, by their outline and also by the position of the leaf scars, are much like those of *L. clypeatum.* But they are always symmetrical, not inclined on one side, transversely rhomboidal, with all the angles acute, especially the lateral ones which are rather narrowed and acuminate. They measure nearly two centimeters horizontally and only twelve millimeters vertically. The leaf scars are separated from the upper borders by a narrow margin, two millimeters broad, as in *L. clypeatum.* They have the same configuration as the bolsters, being only proportionally narrower, seven millimeters broad, with lateral angles acute, three to four millimeters vertically, the upper corner mammillate and more acute than the lower, which is obtuse or half round. The mamilla is transversely oval and larger than the medial vascular scar.

As seen from the specimen kindly communicated by Prof. Andrews this is evidently a distinct species.

Habitat—Base of the coal measures, near Rushville, Perry county, Ohio, (Prof. E. B. Andrews), with *Archeopteris*, *Megalopteris* and the other species published by the author.

LEPIDODENDRON CLYPEATUM, *Lesqx., Pl. LXIV, Figs. 16, 16a, 16b, (17, 18?)*

Boston Jour. S. N. H., v. VI, p, 429. Geol. of Penn'a, 1858, p. 875, Pl. XV, f. 5; XVI, f. 7. Geol. Rept. of Ill., II, p. 455. Schp., Paleont. veget., II, p. 27.

Lepidophloios irregularis, Lesqx., Geol. Rept. of Ark., II, p. 311, Pl. IV, f. 3.

L. Lesquereuxii, Andrews, Geol. Rept. of Ohio, Paleont., II, p. 423, Pl. LIII, f. 3.

Bolsters irregularly rhomboidal, nearly as broad as long, with sides obtuse and unequilateral; inside scars transversely rhomboidal-oval, acute on both sides; vascular scars and appendages distinct; cauda obsolete or none.

This form is common and very variable. F. 16 represents a young fragment remarkable for the shape and position of the bolsters which give to it the appearance of a

Lepidophloios. The bolsters are generally distinct and not imbricating as in this figure, with obtusely curved sides, always unequilateral, more expanded on one side than on the other, a character which I have remarked in all the numerous specimens which I have had for examination. The scars are generally flat, margined in the upper part, but sometimes the border is broad and continuous all around. In the decorticated state the bolsters are marked by a central small obtuse mamilla gradually effaced downward as in f. 16*b*. The decorticated scars of f. 17 and 18 are doubtfully referable to this species.

Though Schimper supposes that it may be a modified form of *L. obovatum*, I consider it as specifically different. I have not seen any European specimen nor any description or figure of European authors representing its more marked characters, the short bolsters, nearly as broad as long, with unequilateral sides. Prof. Schimper also refers to this species *Lepidophloios irregularis*, Lesqx., l. c. This may be right; but in both this and *L. Lesquereuxii*, Andrews, which is apparently the same species, the bolsters are narrower, scarcely or not at all unequilateral. The specimens of these two species are too fragmentary for conclusive observations. *Lepidophloios irregularis*, however, is positively a *Lepidodendron* as well as *L. Lesquereuxii.*

Habitat—Seen in most of the localities where I have found *Lepidodendron* from the subconglomerate Coal of Helena, Ala., to the Cannelton Coal of Pennsylvania; also common in Illinois.

LEPIDODENDRON COSTATUM, *Lesqx., Pl. LXIV, Fig. 4.*

Geol. Rept. of Ill., II, p. 453, Pl. XLIV, f. 7.

Bolsters vertically continuous, separated lengthwise by broad striate uninterrupted wrinkled ribs; inside scars large, transversely rhomboidal, the upper border emarginate, the lower very obtuse.

The outline of the bolsters is merely indicated by a deeper shade as seen on the figure. Though in spiral order, they are alternately disposed in vertical series and the rows separated by distinct striate ribs, like those which characterize costate species of *Sigillaria*. The regularity of these ribs observed upon a large specimen prevent the supposition that they are due merely to some disruption of the bark, like those of species of *Ulodendron*.

If it was not for this peculiar character, the fragment might be referable to the following species and considered as derived from an older part of the stems. Both these forms together with *L. Brittsii*, represent the type of *L. Volkmannianum*, St., diversely and beautifully represented in Stur., Culm. Fl., Pl. XVIII, f. 4; XXIII, f. 2–5.

Habitat—Chester group, subcarboniferous of Ill., Prof. A. H. Worthen.

LEPIDODENDRON TURBINATUM, *Lesqx., Pl. LXIV, Fig. 5.*

Geol. Rept. of Ill., II, p. 453, Pl. XLIV, f. 6. Schp. Paleont. veget., II, p. 28.

Bolsters broadly obovate, obtuse at the top and the contracted wrinkled base; inside scars transversely enlarged and narrow; vascular scars distinct, appendages none.

Except the narrower scars, the distinctly marked borders of the bolsters, narrowed to an obtuse base and without intermediate ribs, there is no difference in the characters of both this and the former species.

Habitat—Subcarboniferous of Ill., Chester group, from a different locality than the former, Prof. A. H. Worthen.

LEPIDODENDRON RHOMBICUM *St., Pl. LXII, Figs. 4, 4a; Pl. LXIV, Fig. 18?*

Bergeria rhombica, Presl., in St., Flor. d. Vorw., II, p. 184, Pl. LXVIII, f. 18.

Lepidodendron rhombicum, Schp., Paleont. Veget., II, p. 37.

Bolsters subquadrate-rhomboidal, marginate, with equal sides and obtuse angles, marked at the top by a small oval mamilla.

This form and also *L. quadratum* and *L. marginatum*, St., are described by Schimper as species of uncertain relation established from decorticated young specimens. The small punctiform inside scars are described by the same author as perforated in the middle. I have not observed this character in any specimens which I think represent the species.

It is well to remark that if the determination of *Lepidodendron* is difficult and somewhat uncertain when based upon scars fully developed and distinctly preserved, it is still more hazardous when made from the decorticated scars of young branches. Pl. LXIV, f. 18, Atl., is referred hypothetically either to this species or to *L. quadratum*, St., or to *L. clypeatum*.

Habitat—A number of specimens considered as representing *L. rhombicum* are all from Burnt Branch of Canney, Ky. Specimen f. 18 is from Wilkesbarre. It is L. 37 in the Museum of Comp. Zool., Cambridge.

LEPIDODENDRON QUADRANGULATUM, *Schloth.*

Palmacites quadrangulatus, Schloth., Nacht. Z. Petref. p. 395, Pl. XVII, f. 18.

Aspidiaria Schlotheimiana, St., Fl. d. Vorw., II, p. 181, Pl. LXVIII, f. 10.

Lepidodendron drepanapsis, Wood, Proceed. Am. Nat. Soc. Phil., v. XII, 1860, p. 240, VI, f. 2.

Bolsters large, rhomboidal-quadrangular, more obtuse at the upper end, a little more elongated and narrower at the lower; scars inflated, placed at the upper angle of the bolsters, transversely rhomboidal, with the lower border half round; vascular scars and appendages none; cauda transversely rugose.

The bolsters measure one and a half to two centimeters in diameter, and are vertically a little longer than transversely. The inside scar is thick or upraised, exactly rhomboidal as marked in the original figure of Schlotheim, or rounded on the lower side as in f. 10, St., l. c., and in Dr. Wood, f. 2. Both Schlotheim's and Sternberg's species are the same, for Sternberg remarks that he received his specimen from Schlotheim. The inside scars are either very close to the top of the bolsters or placed a little lower, their upper angle corresponding to that of the bolsters. The species is not mentioned by Schimper. It seems however very distinct especially by the inflated or upraised inside scars, probably in a decorticated state.

Habitat—A very rare form; known to me merely by the figures. The specimen represented by Dr. Wood is in the cabinet of the Academy of Nat. Sci. of Phila.; its locality is unknown.

§ 2. *Species with inside scars placed in the upper third part of the bolsters.*

LEPIDODENDRON DICHOTOMUM, *St., Pl. LXIV, Fig. 3.*

1st type, bolsters rhomboidal.

L. dichotomum, Brgt. Hist. d. veg. foss., II, Pl. XVI, f. 2. St., Fl. d. Vorw., I, Pl. II; Pl. LVI, f. 2; II, Pl. LXVIII, f. 1. Gein., Verst., p. 34, Pl. III, f. 2, 3, 5.

L. Sternbergii, Schp., Palæont. Veget., II, p. 19.

2d type, bolsters obovate.

L. dichotomum, Gein., Verst., p. 34, Pl. III, f. 6–12.

L. obovatum, St., I, Pl. VI, f. 1; Pl. VIII, f. 1A, II, Pl. LXVIII, f. 6. Ll. & Hutt., Foss. fl., I, Pl. XIX, bis. Lesqx., Geol. of Pa., 1878, p. 874. Geol. Rept. of Ill., II, p. 455.

L. elegans, Brgt., l. c., II, Pl. XIV. Ll. & Hutt., l. c., II, Pl. CXVIII; III, Pl. CXCIX.

L. gracile, Brgt., l. c., II, Pl. XV.

L. rugosum, Presl., in St., l. c., II, Pl. LXVIII, f. 4.

L. Mannebachense, St., ibid., Pl. LXVIII, f. 2.

1st Type. Bolsters rhomboidal; sides angular, inside scars transversely rhomboidal, the upper border rounded, the lower acute in the middle at the point of union of semilunar basilar lines; vascular points and appendages distinct in the large scars; cauda wrinkled; leaves lanceolate acuminate, half open, more or less distinctly nerved; strobile long; cylindrical bracts lanceolate.

2d Type. Bolsters obovate, not angular on the sides.

The young branches of this species have generally rhomboidal angular bolsters. In the branch figured by Brgt., l. c., Pl. XVI, f. 1, the same also represented by St., l. c., Pl. I, the upper branches have the bolsters square-rhomboidal while, towards the base of the stem, they become elongated and obovate. I must say that though I have seen long stems referable to the first type by the shape of the bolsters, I have not seen these passing to the second type even in considerably enlarged fragments. Thus, for example, a dichotomous stem of this species, twenty-four centimeters long, two centimeters broad, has the bolsters of its base still more enlarged transversely and more distinctly angular on the sides than at the top of the branchlets.

The description of the leaves and strobiles is taken from specimens figured by European authors. *L. obovatum* is extremely common, easily recognizable by its impressions generally distinct, the bolsters narrowly but deeply margined, gradually enlarging upwards from an acute base and thus obovate, largest above the middle. The inside scars are small, one third of the diameter of the bolsters, and like the appendages and the cauda also, very distinctly marked. The bolsters are more or less enlarged and of various length according to their age. In flattened specimens the borders are generally narrow, marked by a mere line. The epidermis, rarely preserved, is distinctly striate, as seen Atl., Pl. LXIV, f. 3. It renders the shape of the bolsters somewhat obscure. When decorticated they are marked only by a central round mamilla.

Habitat—The whole extent of the coal fields; most common above the conglomerate.

Lepidodendron modulatum, *Lesqx., Pl. LXIV, Figs. 13, 14.*

Boston Jour. S. N. H., v. VI, p. 428. Geol. of Penn'a, 1858, p. 874, Pl. XV, f. 1. Geol. Rept. of Arks., II, p. 310, Pl. III, f. 1, 1a. Geol. Rept. of Ill., IV, p. 430. Schp., Paleont. Veget., II, p. 25.

L. conicum? Lesqx., Geol. of Penn'a, l. c., p. 874, Pl. XV, f. 3.

L. mekiston, Wood, Proceed. Acad. Nat. Sc., Phil., 1860, p. 239, Pl. V, f. 3.

L. politum, Lesqx., Geol. Rept. of Ky. (D. D. Owen), III, p. 556, Pl. VII, f. 1.

Bolsters oval, largest in the middle, equally narrowed and acuminate at both ends; separated by a broad half cylindrical border or furrow, obliquely and finely wrinkled; inside scars lower than in the former species and broader, rhomboidal, the upper side curving both ways from a conical point; vascular scars, etc., as in the former species.

Though the differences which separate this species from the former are not very marked, they are, however, persistent, and therefore distinct. They may be recognized even upon very small branches with top bolsters four millimeters long, one and a half millimeters broad, the basilar ones of the same branches being already double this size, and all separated by a wrinkled half cylindrical border, as on the largest bolsters of the species which measure four and a half to five centimeters long, and nearly two centimeters broad inside of the borders. These, according to the size of the bolsters, vary from one to three millimeters in width. One of the trunks whose impressions have been left upon the sandstone of Little Beaver river, Penn'a., represents the species with the characters of the bolsters preserved upon its whole length. The inside scar is topped by a transversely rhomboidal inflation, as in the other species of this section.

L. conicum, Lesqx, appears referable to this species. The specimen from which the description was made being flattened by compression, the borders of the bolsters are flat, and of course somewhat broader; the inside scars are deformed, and placed a little higher. I have not seen any other fragment representing this form.

Habitat—Less common than the former, and appearing lower in the coal measures. Subconglomerate coal of Arkansas, Mazon creek, and shale of the coal of Morris, Ill. Carbondale, in Mr. Clarkson's collection, specimens of both the normal and flattened forms.

LEPIDODENDRON CARINATUM, *Lesqx.*

Boston Journ. S. N. H., v. VI, p. 429. Geol. of Penn'a, 1858, p. 875, Pl. XV, f. 4. Schp., Paleont. Veget., II, p. 27.

Bolsters of small size, oval-hexagonal, angular on the sides, acute at both ends; borders narrowly deeply and sharply keeled; inside scars broadly rhomboidal, slightly enlarged on the sides; vascular scars and appendages distinct; cauda basilar.

This form is represented only by the specimen figured. The bolsters are one and a half centimeters long, eight millimeters broad, the inside scars transversely three millimeters, and two vertically. I consider as essential characters of this species the shape of the broad and short bolsters, surrounded by deep, sharply carinate borders, disposed in an elongated rhomboidal hexagonal outline, the four upper and lower sides being longer than the two middle ones which are parallel.

Habitat—Carbondale, Penn'a, low coal. There is a specimen of this species in the cabinet of Prof. Hildreth, at Marietta. It is without label.

LEPIDODENDRON DISTANS, *Lesqx.*, *Pl. LXIV, Fig. 10.*

Boston Jour. S. N. H., v. VI, p. 429. Geol. of Penn'a, 1858, p. 874, Pl XVI, f. 5. Schp., Paleont. Veget., II, p. 27.

L. oculatum, Lesqx., Geol. of Penn'a, l. c., p. 874, Pl. XVI, f. 4.

L. cheilaleum, Wood, Trans. Am. Phil. Soe., XIII, p. 346, Pl. IX, f. 4.

Bolsters rhomboidal-ovate; sharply acute at both ends, distant; interspaces broad, undulately striate or wrinkled lengthwise; inside scars rhomboidal; vascular scars and appendages distinct; cauda deep, broadly rugose.

The bolsters are of medium size, nearly rhomboidal-oval, a little narrower and more elongated in the lower part. They are very regularly placed in a same relative distance, equal to half their width, in measuring it in their spiral direction. Thus, in the three figures of this species, given from specimens representing different ages, the first *L. oculatum*, l. c., has the bolsters three centimeters long, thirthirteen millimeters broad, and the space left between them seven millimeters. In *L. distans*, the bolsters, two centimeters long, nine millimeters broad, are five millimeters apart, and in *L. Cheilaleum*, representing a young specimen still covered with the epidermis, the bolsters one centimeter long, five millimeters broad, are still three to four millimeters distant. Comparison of this kind made from specimens obtained from distant localities and referable to divers parts of trees, in various stages of growth, sufficiently contradict the opinion of those who wish to reduce to very few types the species of the coal flora, considering the differences of character as resulting from mere casual causes.

Habitat—Carbondale. Seen in Mr. Clarkson's cabinet, in very large specimens. The specimen described by Dr. Wood is in the museum of the Acad. Nat. Soc. of Phil.

LEPIDODENDRON CUSPIDATUM, *Sp. nov., Pl. LXIV, Fig. 7.*

Bolsters closely contiguous, imbricating on one side, obovate, acuminate at both ends, more elongated in the lower side; inside scars triangular, cuspidate by a short narrow ridge in the middle of the lower side, corners obtuse; vascular points distinct, the middle one twice as large; appendages distinct, small; decorticated scars oval, with a central oval mamilla and a short narrow ridge at the top.

The figure represents only three bolsters of two large specimens, one with, the other without the cortex. The shape of these scars is peculiar. I have not seen its like until now, neither upon American specimens, nor figured by authors. I do not even see to which species it might be compared.

Habitat—The two specimens are in the cabinet of Mr. R. D. Lacoe, Nos. 717 and 718, from Plymouth E vein, Pittston, Penn'a.

LEPIDODENDRON WORTHENII, *Lesqx., Pl. LXIV, Figs. 8, 9.*

Geol. Rept. of Ill., II, p. 452, Pl. XLIV, f. 4, 5. Schp., Paleont. Veget., II, p. 28.

Bolsters small, oblanceolate, spindle shaped, narrowed, decurrent and continuous to the base; inside scars vertically narrow, transversely as broad as the bolsters, half round at the upper border and cuspidate in the middle when corticated, nearly truncate at the base; vascular points in the upper part of the scars; appendages and cauda none.

The fragments figured represent small stems with bolsters comparatively long and narrow, two centimeters long, four to five millimeters broad. The specimen f. 8 has the surface covered with the epidermis, the bolsters transversely rugose, gradually narrowed to an acuminate base, with the inside scars mucronate. In older branches the bolsters are less rugose, with the upper borders of the scars half round. All the specimens I have seen of this species have the same characters, and represent the same size, either upon stems or branches. Distantly related to *L. Brittsii.*

Habitat—Murphysborough, Jackson county, Ill.

LEPIDODENDRON ANDREWSII, *Sp. nov., Pl. LXIV, Fig. 6.*

Bolsters small, very inflated, obovate, smooth; inside scars rhomboidal, transversely enlarged, base and top obtuse; vascular scars in the lower part; no trace of appendages nor of cauda.

A mere fragment of a young branch or stem, with bolsters prominent and extremely distinct. The species, like the former, is of the type of *L. Volkmannianum*, St. But the inside scars are not as broad, not near the top of the bolsters, and more enlarged vertically.

Habitat—Mazon creek in nodules.

LEPIDODENDRON QUADRILATERALE, *Andrews.*[*]

L. Lesquereuxii, Andrews, Elem. of Geol., p. 117, f. 307.

Bolsters large, broadly rhomboidal, with equilateral sides of equal length; surface longitudinally striate; borders upraised; leaf scars nearly in the middle, triangular, transversely enlarged, the upper sides parallel to the borders of the bolsters, the base truncate; cauda thick, distinct; vascular scars obscured by the striæ of the thin cortex.

A peculiar species, distantly comparable to *L. Veltheimianum.* The bolsters are exactly rhomboidal or square, when seen in their spiral direction; the borders obtusely keeled, each side measuring two centimeters. The triangular leaf scar bear at the top a small rhomboidal mamilla; the appendages and cauda are very distinctly marked, as in *L. Veltheimanium;* the surface is covered by a thin layer of smooth shining coal, wrinkled lengthwise.

Habitat—Base of the coal measure, Perry county, Ohio.

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[*] Elem. of Geol., 2d Ed., inedit.

§ 3. *Inside Scars in or about the middle of the bolsters.*

LEPIDODENDRON FORULATUM, *Lesqx., Pl. LXIII, Fig. 9–10a.*

Geol. Rept. of Ill., IV, p. 431, Pl. XXIII, f. 5–8. Schp., Paleont. Veget., III, p. 534.

Bolsters distant, spindle-shaped, narrowed and acuminate at both ends, transversely rugose, separated by flat narrow parallel ribs and intervals irregularly striate lengthwise; inside scars central, rhomboidal, obtuse at the top, truncate or obtusely pointed at the lower part; vascular scars distinct; appendages and cauda none; cortex thick, narrowly and regularly striate; decorticated scars small, regularly rhomboidal, decurring into a short cauda.

The bolsters, one and a half centimeters long, five to seven millimeters broad, are separated as in *Sigillaria*, by narrow vertical equidistant ribs. The thick epidermis is narrowly striate, the central part of the bolsters only being marked by a small smooth round space. The subcortical leaf scars f. 10 and 10*a*, are distinct, rhomboidal, or half round, placed in the middle of a smooth round convex surface, their obconical base is traversed by a short and narrow line or cauda.

The species is closely allied to *Ulodendron ellipticum*, St., represented Atl., Pl. LXV, f. 2, 3. The ribs are, however, more regular in size and length, the bolsters longer, and the decorticated scars of a different character.

Habitat—St. John's coal, Ill.

LEPIDODENDRON DIPLOTEGIOIDES, *Lesqx., Pl. LXIV, Fig. 2.*

Geol. Rept. of Ark., II, p. 311, Pl. IV, f. 2; Geol. Rept. of Ill., II, p 452; Pl. XLIX, f. 2. Schp., Paleont. veget., II, p. 28, Pl. LX, f. 7.

Bolsters oval-rhomboidal and acuminate at both ends, with broad flat smooth borders; inside scars transversely spindle-shaped or narrowly rhomboidal, with both side acute: vascular scars large; cauda marked by a few trans-

versal wrinkles; decorticated bolsters rhomboidal, with br ad flat margins crossed by a vertical medial line.

The bolsters, one and one half centimeters in length, are only five millimeters broad in the middle.

Schimper compares this species to *L. confluens*, St., referable by the same authority to *L. aculeatum*, St. As both figures are placed aside, f. 1 and 2 of Atl., Pl. LXIV, the degree of relation is easily observed. The decorticated bolsters of *L. aculeatum* are marked, as far as I know them, by a round central mamilla.

Habitat—Subconglomerate coal of Arks. Colchester, Ill., first coal above the conglomerate. Not found elsewhere.

LEPIDODENDRON TIJOUI, *Lesqx.*

Geol. Rept. of Ill., IV, p. 431, Pl. XXIV, f. 1, 2. Schp., Paleont. veget., III, p. 535.

L. dicrocheilum, Wood, Proc. Acad. of Phil., 1860, p. 239, Pl. VI, f. 1. Trans. Am. Phil. Soc., XIII, p. 346, Pl. IX, f. 6.

L. caudatum, var., Roehl., Foss. fl., p. 130, Pl. VI, f. 7.

Bolsters oval, acuminate at both ends, separated by a flat, smooth or wrinkled border; inside scars large, transversely rhomboidal-ovate; upper and lower borders obtuse, the upper one more convex; vascular scars large; appendages and cauda none; decorticated bolsters marked lengthwise by a deep medial line, half the length of the bolsters.

The fragment from which the species is described seems to represent part of a large stem, though the bolsters are of small size, one and a half centimeters long and five millimeters broad.

This species resembles the former. The bolsters are more sharply acuminate, and when decorticated they are without border, preserve exactly the same form and size as those covered with the cortex, and the leaf scars are placed a little higher. The epidermis as seen upon a fragment of another specimen is a thin pellicle of coaly matter with smooth surface, upon which the outlines of the bolsters are merely obscurely traced.

L. dicrocheilum, Wood, l. c., is apparently a mere form of this species. In f. 1, l. c., the intervals between the bolsters are evidently rugose, and the leaf scars are placed in the middle. In f. 6 however the scars are above the middle and the intervals smooth.

Habitat—St. Johns coal bank, Ill. Broad Top, Cook's coal, Dr. H. C. Wood.

LEPIDODENDRON OBTUSUM, *Lesqx.*

Boston Jour. S. N. H., v. VI, p. 429. Geol. of Penn'a, 1858, p. 875, Pl. XVI, f. 6. Schp., Paleont. Veget., II, p. 26.

L. venustum, Wood, Trans. Am. Phil. Soc., XIII, p. 347, Pl. IX, f. 1.

Bolsters rhomboidal, acute at the top, obtuse at the lower end, margined; inside scars central, small, transversely rhomboidal, the upper border obtuse, the lower curved on the sides, joined in the middle into a short decurring acumen; appendages distinct, small; cauda strong, transversely rugose.

Species comparable to *L. modulatum.* The bolsters are much shorter and comparatively broader, a little more than two centimeters long, one and a half broad; the inside of the borders are narrower and wrinkled or rather striate in right angle. The leaf scars are exactly in the middle, of the same form as in *L. modulatum*, topped first by a semilunar line and above it by a conical impression. The figure of Dr. Wood, l. c., represents a younger fragment in a better state of preservation. The characters are the same. Schimper, l. c., supposes that *L. giganteum*, Lesqx., may represent old scars of this species.

Habitat—Carbondale, Mr. Clarkson's collection. Dr. Wood's specimen is in the collection of the Acad. of Philadelphia, locality unknown.

LEPIDODENDRON RIMOSUM, *St., Pl. LXIV, Fig. 11.*

St., Flor. d. Vorw., I, p. 21, Pl. X, f. 1. Roehl, Foss. fl, p. 132, Pl. VIII, f. 1; Pl. X, f. 2. Lesqx., Geol. of Penn'a, 1858, p. 874. Schp., Paleont. Veget., II, p. 33, Pl. LX, f. 8-8a.

Sagenaria rimosa, Presl., in St., fl. d. Vorw., II, p, 180, Pl. LVIII, f. 15. Gein., Verst., p. 35, Pl. III, f. 13-15.

L. rimosum and dissitum, Sauv., Veg. foss., Belg., Pl. LX, f. 6: Pl. LXII, f. 1 (fide Schp.).

L. simplex, Lesqx., Geol. Rept. of Ill., II, p. 454, Pl. XLV, f. 5.

L. dubium, Wood, Trans. Am. Phil. Soc., XIII, p. 344, Pl. VIII, f. 4.

Bolsters fusiform or narrowly rhomboidal, elongated *and acuminate at both ends, convex, carinate, rarely contiguous, more or less distant; intervals wrinkled lengthwise; inside scars central, small, rhomboidal.*

The species is common and variable. The bolsters are very narrow, comparatively to their length, two to three centimeters long, three to five millimeters broad in the middle; the inside scars are proportionally small with the vascular dots generally indistinct, forming in the middle an elongated triangle by lines passing transversely across the tree basilar scars, and ascending to a small point above them, as marked f. 11. Geinitz in enlarged f. 13, l. c., marks three basilar round vascular scars and one above them.

The bolsters are generally somewhat distant, with intervals wrinkled lengthwise. But they are also, it seems, sometimes contiguous, merely separated by a narrow inflated border, as figured in Gein., l. c., f. 15. It is from a specimen of this character with the borders of the bolsters marked by a mere thin line, that I described *L. simplex*, which, if Geinitz is correct, has to be considered as a variety of this species. For indeed the leaves of which the German author has figured a fragment, are narrow, two millimeters, exactly of the same width and character as those of *L. simplex*, and the cone which Geinitz refers to this species under the name of *Lepidostrobus variabilis* is also remarkably like *L. princeps*, Lesqx., l. c., f. 6. It is however certain that even if *L. simplex* is a mere variety of *L. rimosum*, the reference of the cone to this species is more than doubtful, as these strobiles were not found at the same locality and have nothing in their characters indicating a relation either to this *Lepidodendron* or to *Lepidostrobus variabilis*, Ll. and Hutt. Schimper does not quote that f. 15 of Geinitz as referable to *L. rimosum*, considering it perhaps as a different species. But Roëhl, Pl. X, f. 2, l. c., represents the same form under this specific name.

In the decorticated state, the bolsters, generally tipped by a short linear ridge, are often much elongated and continuous, so that the surface of the specimens resembles that of large *Calamites*.

Habitat—Lower coal measures above the Millstone grit. Colchester, Morris, Ill.; Hausville coal, Ky., and Pottsville, Pa., as *L. simplex*. Specimens in the collection of Mr. R. D. Lacoe represent *L. rimosum* with distant scars. The frequency of the form *L. simplex* which is very rare in Europe and the scarcity here of the representatives of the true *L. rimosum*, seems to point to a specific difference between them.

LEPIDODENDRON CRENATUM, *St.*

Fl. d. Vorw., I, p. 10, Pl. VIII, f. 2 B. Goepp., Syst., p. 465, Pl. XLII, f. 4, 5, 6.

Sagenaria crenata, Brgt., Prod., p. 86. St., l. c., II, p. 178, Pl. LXVIII f. 5.

Bolsters rhomboidal-fusiform, narrowed and acute at both ends. Inside scars nearly in the middle, large, rhomboidal, obtuse at the top, acute at the sides and at the base; appendages more or less distinct; cauda enlarged downward, broadly rugose.

Schimper considers this species as a form of *L. aculeatum*. The inside scars are larger nearly as broad as the bolsters, about central. It has the characters of *L. Veltheimianum*, St., as figured in Stur, Culm. flora, Pl. XIX, f. 5, at least from the American specimens which I consider as representing it and which are remarkably similar to the figures of the German author.

Habitat—Subconglomerate coal of Port Byron, Ills., Mr. I. H. Southwell.

LEPIDODENDRON CYCLOSTIGMA, *Sp. nov., Pl. LXII, Fig. 5.*

Bolsters broadly rhomboidal, acute at both ends, rounded on the sides; inside scars central, mamillate, nearly round; cortex indistinctly marked by the outlines of the leaf scars.

The great size of the fragments which represent this species shows them to be derived from large trees. But though well preserved, even with the epidermis, the bolsters and scars do not have any feature different from what I have figured, nor any character indicating a reference to another species of this genus. The outlines of the bolsters resemble those of some varieties of *L. clypeatum*, but the inside scars are of a different character. The bolsters are all of the same size, twelve millimeters in vertical direction and one centimeter broad.

Habitat—Clinton coal. communicated in large specimens by Dr. J. H. Britts.

Species of uncertain reference.

LEPIDODENDRON MIELICKII, *Goepp., Pl. LXIV, Fig. 12.*

Goepp., Syst., p. 465, Pl. XLIV, f. 1, 2. Lesqx., Geol. of Penn'a, 1858, p. 875. Schp., Paleont. veget., II, p. 35.

Bolsters (decorticated) rhomboidal, narrower and blunt or nearly acute at both ends, obtuse on the sides, surrounded by an elevated smooth border, inside scars central, oval, large, their places after abrasion being marked by a small round depression.

Goeppert's figure represents, together with the decorticated bolsters as described above, the counterpart or corticated surface, rendered obscure by the epidermis transformed into a thin layer of coaly matter. The reference of this species is uncertain. A number of specimens of *Lepidodendron* have in the decorticated state a similar appearance and therefore remain undetermined. The likeness of the bolsters of the specimen American, especially the prominent smooth border and the oval central scar, authorize its reference to Goeppert's species without giving any more indications about its true relation.

Habitat—Summit Lehigh, Penn'a.

LEPIDODENDRON GASPIANUM, *Daws.*

Geol. Surv. of Canada, Foss. pl., (1871), p. 33, Pl. VIII, f. 82-84.

Bolsters contiguous, elliptical; leaf scars central; leaves thick at base, circular, slightly ascending and curving downward, short; strobiles small, lateral branches slender, straight and very uniform in thickness; areoles prominent in decorticated stems.

The description is copied from the author. Neither the leaves nor the strobiles are figured; at least the fragments of leaves attached to the side of f. 83 are quite obscure and their character is unascertainable. The strobile, f. 84, is like an inflated branchlet covered with leaf scars. The bolsters are very small, three millimeters long and half as broad, contiguous and in parallel rows as in some species of *Sigillaria.*

Habitat—New York State; specimen in Prof. Hall's collection from the Catskill group.

LEPIDODENDRON CHEMUNGENSE, *Hall.*

Geol. Rept. of New York State, p. 275, f. 127.

Decorticated stem covered with oval, acuminate, scale-like areoles, more acute and smaller in proportion to the size of the stem than in L. Gaspianum.

Species represented by a young branch with the bolsters only distinct. Schimper, Paleont. veget., marks it as probably referable to *L. Sternbergii.*

Habitat—Chemung group, New York State. A small specimen figured Geol. of Penn'a, 1858, II, p. 829, f. 677, appears referable to this species, according to the remarks of Prof. Rogers. It is from the Chemung of Penn'a.

LEPIDODENDRON ICTHYOLEPIS, *Wood.*

Lepidophloios icthyolepis, Wood. Proced. Acad. Nat. Sci., Phil., (*1860*) *p. 240, Pl. V, f. 5.*

Stem large; cortex thin; bolsters approximate, raised, furnished with an appendix on each side and one in the middle; vascular scars not preserved.

This description is that of the author. From the figure, the specimen seems to represent decorticated impressions of broadly rhomboidal bolsters, obtuse at the upper part, confluent at the base, with the inside scar marked by an inflation at the top, and a smooth ridge descending from it like a cauda. The specimen is undeterminable.

Habitat—Roof of Tunnel vein, Dauphin co., Pa. Specimen in the Cabinet of the Academy.

LEPIDODENDRON OBSCURUM, *Lesqx.*

Geol. Rept. of Ill., II, p. 453, Pl. XLIV, f. 1–3.
L. diplotegioides, (decorticated), Schp., Paleont. veget., II, p. 28.

Bolsters obscurely marked, flat, rhomboidal-oval, narrowed and acute to both ends, distant; intervals irregularly striate, deeply furrowed in the old parts of the stems; inside scars central round or oval.

As Schimper states it, these decorticated fragments may represent *L. diplotegioides* but may be referable also to other species, as for example to *L. Charpentieri*, Goepp., Syst., p. 433, Pl. XLII, f. 1, which Schimper identifies with *L. aculeatum.*

Habitat—Subconglomerate measures.

LEPIDODENDRON RADICANS, *Lesqx.*

Geol. Rept. of Ill., II, p. 454, Pl. XLVI, f. 1. Schp., Paleont. veget., II, p. 28.

Bolsters large, oblong-rhomboidal or oval, narrowed, decurring, flexuous and continuous at both ends, ribbed lengthwise; inside scars about central, obscurely marked, oval.

The large bolsters are covered with flattened ribs or large and flexuous striæ, resembling the impressions of a coating of rootlets, like those of *Caulopteris macrodiscus* or *C. Mansfieldi*, Atl., Pl. LX, f. 3. Schimper supposes that it may represent a peculiar state of *L. confluens*, St., which is, a decorticated form of *L. aculeatum.* I have not seen any decorticated *Lepidodendron* with the surface marked by striæ or longitudinal flexuous ribs and still believe that the specimen described above may represent merely a piece of bark of a *Caulopteris.*

Habitat—Duquoin, Ills.

ULODENDRON, *Rhode.*

Stems arborescent, rarely branching, bearing, in two opposite rows, round or oval scars, impressions of the base of strobiles, marked with concentrical scales and a central mamilla; leaves short, lanceolate; leaf scars disposed in *spiral, comparatively small, distinctly rhomboidal or oval-oblong, sub-rhomboidal. Fructifications in long cylindrical strobiles.*

Goeppert, Geinitz, Heer and Stur have not separated this genus from *Lepidodendron.* Brongniart and Weiss are not positive in regard to the value or authority of this separation. But from Sternberg to Schimper most of the phytopaleontologists have admitted this generic division on reasons which seem indeed legitimate.

Schimper has clearly exposed the essential characters which separate these two genera. His views fully agree with the observations made from American specimens, and exposed already in Geol. Rept. of Ill., IV, p. 434–35.

1st. The trunks of *Ulodendron* seem to have been simple or scarcely ramified, like those of *Sigillaria.* Except a small branch of *U. minus* on which remark is made in the description of the species, I have never seen any trace of division of the stems, though the collections of Mr. S. S. Strong and of Mr. R. D. Lacoe, have truncs of *Ulodendron* one meter long or more.

2d. The leaf scars or bolsters are scarcely variable in size, or not much larger upon trunks of great size than upon small ones. By the growth of the trees the bark is split lengthwise, and the intervals between the borders are filled by linear woody excrescences which sometimes expand laterally and partly cover the scars or the bark. All the phytopaleontologists have observed that kind of fissures on the bark. Though it is a mere result of growth, it indicates for the internal tissue a composition or disposition different from that of *Lepidodendron.*

3d. The inside scars of *Ulodendron* differ positively from those of *Lepidodendron.* When decorticated, they are merely punctiform, either deep points, or small mamillas, surrounded by a ring as in Atl., Pl. LXVI, f. 2*a*. On the same plate, f. 3, the corticated bolsters of *U. majus*, are represented with three vascular scars as in *Lepidodendron;* but under the epidermis these scars are not seen at all; under the first layer of bark they are mere points as in f. 3*a*.

Large specimens of this species are sometimes found without any scars of strobiles and are surely determined by the characters of these punctiform impressions.

I have never been able to find any leaf attached to the stems, even the smallest branches are without remains of these organs. Schimper describes them as short, lanceolate, rigid, as seen from a specimen figured by Geinitz.

The large disks placed in double series, which especially characterize this genus, are round or oval, and variable in size as they increase in diameter with the growth of the trees, from the base of the trunks upwards. They are generally marked in the center by a small circular mamilla, around which the leaf scars are concentrically placed as imbricated, gradually enlarging towards the borders, generally obscure disfigured impressions, sometimes totally erased or diversely shaped.

Lindley and Hutton have considered the disks as resulting from the attachment of strobiliform inflorescences, or of cones of fructifications. Brongniart, per contra, regards them as scars of conical tubercles covered with leaf scars, their central part being an incipient branch or an adventive root. Schimper admits Ll. and Hutt. opinion, which seems indeed the more probable for the generality of the species. But some of the American specimens apparently represent different generic characters, implying the authority of the conclusions admitted by each of the authors named above.

We have, for example, a small stem of *U. minus*, a dichotomous branch, mentioned above, four centimeters broad at its base where it is broken, abruptly enlarged to six centimeters at the point of division, with strobile-scars only one centimeter in diameter and contiguous, (eleven in number upon a stem fourteen centimeters long). They are marked by central circular dots, like remains of woody axes, one to two millimeters in diameter, transformed into hard shining coal, while the circular depressions around the central points are covered with a smooth epidermis on which the concentrical leaf scars are very obscurely marked. Upon some of these scars the epidermis, a thin hard strong pellicle, covers entirely the central axis while one of the disks seems to bear long scaliform thick leaves, radiating from the central mamilla, like the basilar scales of a cone. Another specimen Pl. LXVII, f. 2, which I have described as a branch of *Ulodendron* has, on the borders, bud-like inflations represented upon the impression of the stem by deep hollows of the same form and character; for they are marked to the bottom of the cavity by the same kind of leaf scars as those of the borders of the stems.

The specimen is a piece of cannel coal which in its soft state has taken the hollow cast of a branch fallen or deposited upon it. Now the small conical protuberances cannot be considered as incipient cones or strobiles. They are evidently bud-like excrescences, thus confirming by their characters Brongniart's opinion of their nature.

A third specimen represents a small disk of *U. punctatum* which, broadly obovate, measures only two and a half centimeters long and seventeen millimeters in width towards the upper end where it is the largest. It has the inflated protuberance marking the point of attachment quite near the lower margin, and is covered with a thick epidermis like the whole disk. Therefore the top of the knobs is smooth without any trace of perforation. It is surrounded by two concentrical circles from which the striæ generally seen upon the disks of this kind, Atl., Pl. LXV, f. 5*a*, radiate in diverging to the borders. From all appearance this is merely an adventive bud and evidently not the disk of a strobile. Does not this prove that in *U. punctatum*, at least, these disks are not scars of strobiles but branch scars, a character which seems already evidenced by the excentrical position and the peculiar shape of the point of attachment which, as far as I have seen in all my specimens, is not circular, but broadly oval or semi-lunar. In that case the genus *Bothodendron* established by Ll. and Hutt. for this peculiar form would be legitimate.

Some of the large strobiles of the Carboniferous have been referred to *Ulodendron* species on account of the concordance in the size of the cones and of the scars upon the disks. This reference is very doubtful; for, as seen above, these strobiles or bud scars are originally small, scarcely one centimeter in diameter; the buds or flowers which they represent have been very early detached, and therefore the large strobiles do not seem to have any relation to the enlarged scars. They probably belong to *Lepidodendron* or *Lepidophloios*.

ULODENDRON COMMUTATUM, *Schp., Pl. LXVI, Figs. 2, 2a.*

Schp., Paleont. veget., II, p. 40, Pl. LXIII, f. 1-6.

Sagenaria Veltheimiana, (St.), Gein., Fil. d. Hayn. Kohlenbass, (ex parte), p. 51, Pl. V, f. 1, 2, 3. Schlumb. and Schp., Terr. de Trans. des Vosges, Pl. XXI.

The above synonymy is copied from Schimper, loc. cit.

Stem large; bolsters (decorticated) somewhat distant, elliptical, narrowed at both ends, slightly obtuse, convex, carinate, marked by a central round impression; disks (of strobiles) very large, broadly oval or nearly round, marked with the impressions of imbricating round scales.

The specimen represents the characters of the species as far as known in a decorticated state. Schimper records in the description of this species the characters of the leaves, one and a half centimeters long, lanceolate, as they have been seen by Geinitz, and those of the corticated bolsters, taken from specimens referred by Goepp. and Gein. to *Lepidodendron Veltheimianum*. I have never seen another specimen but the one figured here. F. 2*a* represents the central point of the leaf scars much enlarged. The disks do not show any central protuberence.

Habitat — Subconglomerate coal of Alabama, Helena mines, communicated by Mr. T. H. Aldrich.

ULODENDRON MAJUS, *Ll. and Hutt., Pl. LXVI, Figs. 3, 3a.*

Ll. and Hutt., Foss. fl., I, Pl. V. Lesqx., Geol. of Penn'a, 1858, p. 875. Schp., Paleont. veget., II, p. 41.

Phytolithus parmatus, Steinhauer, Trans. Am. Phil. Soc., I, p. 286, Pl. VII, f. 1.

Sigillaria Menardi, Lesqx., Geol. Rept. of Ill., II, p. 450, Pl. XLIII.

Stem large; leaf scars rhomboidal-peltate, or with the lower border rounded, marked at the top, in well preserved specimens, by transversely oval inside scars, with three *vascular points; decorticated bolsters transversely rhomboidal with the inside scars of the same form; disks of strobiles large, round, generally umbonate in the middle with the point of attachment slightly excentrical.*

The leaf scars are small and, as far as seen from American specimens, always of the same size, one centimeter from side to side, vertically six to seven millimeters. The scars with their epidermis, as represented in the upper part of f. 3*a*, are very rarely observed, the surface being generally erased or deprived of the cortex. They are more commonly represented as in the lower part of f. 3, or still more generally with the outline border only, without inside scar. On the under surface, the leaf scars are merely marked by a punctiform small mamilla. The disks are large, either marked by defaced leaf scars or by long parallel lines like superposed linear leaves.

Among other American specimens seen of this species one especially, No. 581 of Mr. R. D. Lacoe's collection, is worth describing. It is evidently part of an old stem. The branch scars are opposite, horizontally and vertically at the same distance, sixteen centimeters, exactly circular, five centimeters in diameter, rugose; outside surface marked nearly in the center by a round small protuberance surrounded by smooth rings traversed by narrow striæ. The leaf scars are mostly like those figured in Ll. and Hutt., but somewhat varied, not always half round at the base but rhomboidal, enlarged, broader in the lower than in the upper part, with the inside scars represented as in the lower part of Atl., f. 3, or central, transversely rhomboidal, with a single vascular scar in the middle. The surface is cut by broad vertical keeled smooth ridges, some of which, one and a half centimeters broad and five to six millimeters high. The leaf scars are however of the same size as in smaller specimens.

Habitat—Colchester, Ills., coal above the conglomerate. Pittston, Butler mine E, specimen described above. Subconglomerate coal, Montevallo, Ala., Mr. T. H. Aldrich.

ULODENDRON MINUS, *Ll. and Hutt., Pl. LXVI, Fig. 1.*

Ll. and Hutt., Foss. fl., I, Pl. VI. St., Fl. d. Vorw., II, p. 185, Pl. XLV, f. 5. Schp., Paleont. veget., II, p. 48.

Lepidodendron ornatissimum, Brgt., Hist. d. veg. foss., II, Pl. XIX.

Ulododendron punctatum, St., Fl. d. Vorw., II, p. 186, Pl. XLV, f. 1. Lesqx., Geol. Rept. of Ill., IV, p. 438.

Phytolithus parmatus, Steinhauer, Trans. Am. Phil. Soc., p. 286, Pl. VI, f. 1.

Stems of small size; disks circular, close, leaf scars small, upraised or convex, rhomboidal, marked in the lower part by a vertical short linear impression.

As I consider this species distinct from the following described form, I have mentioned merely the synonyms which I refer to it.

As far as I have seen from numerous specimens, the stems or branches vary from four to sixteen centimeters in width in a more or less flattened state. The leaf scars upon all have the same form as represented in the figure, and generally the same size, three to five millimeters only. The scars of the strobiles are more variable in size, from one to four centimeters in diameter, but always quite close to each other mostly contiguous. The largest specimen which came under my examination, a stem forty centimeters long, fifteen centimeters broad, flattened to five centimeters in thickness, has the disks nearly contiguous, four centimeters wide, exactly round, and the leaf scars five millimeters broad in both directions, while in the smallest stem, four centimeters broad (flattened), the disks, also contiguous, are thirteen millimeters broad and the leaf scars three millimeters. The same characters have been remarked upon all the specimens examined; sometimes however as in Atl., f. 1, there is between the scars a little vertical space. A peculiar specimen representing the branches and the base of a cone of this species is described in remarks on the Genus. The specimen figured by Steinhauer, l. c., has the same characters.

Habitat—Abundantly found in the subconglomerate measures of Alabama, Montevallo, communicated by Mr. T. H. Aldrich. Tennessee, Ætna vein, specimens in Prof.

Jas. Safford's collection. Pittston, in Mr. R. D. Lacoe's cabinet, from Brown Coliery E and Seneca vein F.

ULODENDRON ELLIPTICUM, *St., Pl. LXV, Figs. 2–4.*

St., Fl. d. Vorw , II, p. 186, Pl. XLV, f. 2. Lesqx., Geol. Rept. of Ill., IV, p. 436, Pl. XXII, f. 3; XXIII, f. 1–3.

Lepidodendron ornatissimum, Brgt., Hist. d. Veg. foss., II, Pl. XVIII.

Ulodendron minus, Schp., Paleont. Veget., II, p. 42.

Stems large; leaf scars rhomboidal-ovate, close, acuminate and undulate at both ends; or more or less distant, merely acute, with intervals striate; disks large, broadly oval, distant, irregularly dotted and rugose, or marked by simple lines radiating from a large umbonate center to the borders.

The bolsters or leaf scars of this species are distantly comparable to those of *Lepidodendron Veltheimianum.* They are however much smaller, scarcely one centimeter long, in the largest specimen, and five to six millimeters broad. The inside scar is always small, and as seen upon all the specimens examined, is marked in the middle by a single large vascular scar only. What I have said in the general remarks on this genus, in regard to the equal size of the leaf scars in specimens, parts of trees of different ages, is exemplified by the figures of this species; f. 2, from a younger stem, having the scars contiguous, but of a size equal to those of f. 3 and 4, made from fragments which shows the result of the increasing of the trees in the splitting of the bark into large fissures and the wider space between the leaf scars. The disks of this species are large, five to seven centimeters long, three and a half to four and a half centimeters broad, opposite (not alternate as in *U. minus*), generally equidistant in both horizontal and vertical directions, from eight to twenty centimeters apart upon the specimens examined. I have never seen them marked with a central mamilla as figured in Brgt., l. c.

Habitat—It is common at Morris where no specimens of *U. minus* have been found. Also not rare at Pittston. Both collections of Mr. S. S. Strong and Mr. R. D. Lacoe have splendid specimens of it. The last are from Brown's colliery, E. vein.

ULODENDRON ELONGATUM, *Lesqx., Pl. LXV, Fig. 1.*

Geol. Rept. of Ills., IV, p. 437, Pl. XXIII, f. 4.

Leaf scars distinctly rhomboidal, twice as long as broad, acute at both ends, margined; inside scars exactly central, small, transversely rhomboidal; disks oval, large, distant, pitted with oval impressions of leaves or rugose, with a distinct central unbonate mamilla.

This species may be a mere variety of the former. It differs by the leaf scars narrower, margined, contiguous; by the inside scars exactly central, smaller, and the disks narrower and longer. From the character of the bolsters, this form bears to *Lepidodendron rimosum* the same relation as the former does to *L. Veltheimianum.* The disks upon the specimens on hand are from four to eight centimeters long and only two to four centimeters broad, as far distant as in *U. ellipticum*, and all are marked by three concentrical zones diversely impressed by the scars of the scales. This however is of no account as a character. The specification is merely based upon the shape of the bolsters contiguous upon all the specimens, and the more narrowly oval form of the disks only half as broad as they are long. As in the former species, the disks are opposite.

Habitat—Roof shale of the coal of Morris, Ills.

ULODENDRON PUNCTATUM, *Ll. and Hutt., Pl. LXV, Figs. 5, 5a.*

Bothrodendron punetatum, Ll. and Hutt., Fos. fl., II, Pl. LXXX and LXXXI.

Ulodendron Lindleyanum, St., Fl. d. Vorw., II, p. 185, Pl. XLV, f. 4. Lesqx., Geol. of Penn'a, 1853, p. 875. Schp., Paleont. Veget., II, p. 42.

Caulopteris? acanthophora, Lesqx., Geol. Rept. of Ill., IV, p. 458, Pl. XXVI, f. 3 and 4.

Leaf scars in corticated specimens punctiform, disposed in quincunxial order; disks very large and distant, marked with furrows radiating from an excentrical protuberance to the borders.

Most of the specimens of this peculiar species are very large, with epidermis destroyed. Atl., f. 5, represents, in about one sixth of size, a specimen formerly in possession of Dr. Hildreth of Marietta; f. *5a* is the natural size of the bolsters which are finely preserved. Another specimen partly figured a long time ago from the collection of Mr. Dill of Newark, Ohio, has the disks fourteen centimeters long, ten centimeters broad, the inside scars quite near the lower borders and the surface of the intervals punctate. In the cabinet of Prof. J. P. Lesley at the University of Pennsylvania, there is a specimen of this species with disks quite as large. It is decorticated. The smallest specimen seen of the bolsters of the species is described in the remarks on the genus.

The form described as *Caulopteris acanthophora*, l. c., is of very uncertain relation. It is represented by large specimens of bark, always distinctly punctate and by a branch two centimeters broad, with the surface equally dotted by the base of hooked scales or leaves, some of them still persisting upon the borders. I have seen specimens twenty to thirty square centimeters and could never find any distinct trace of the large scars either of *Caulopteris* or of *Ulodendron*, except a fragment showing part of a border, which would indicate for the disk a diameter of ten centimeters or more. The branch bears a semi-lunar impression which is indeed of a form analogous to that of the disks of *U. punctatum*, and the border of the large scar f. 3, is marked with broad striæ in right angle, exactly like those of f. *5a* of our plate. The only dissent against this relation is the irregular position of the leaf scars. These hooked appendages may represent leaves spines or scales. They have not as yet been observed upon any other fragment. If these specimens truly represent *Bothrodendron punctatum*, as I believe, they confirm the remark made in the description of the genus in regard to the true nature of the disks as branch scars. The semi-lunar impressions in the upper part of these disks are related in shape to those of *Stemmatopteris*. The Genus *Bothodendron* appears therefore to represent a group of arborescent plants intermediate to the Lycopodiaceæ and the Ferns.

Habitat—Mostly found in the conglomerate sandstone, base of the middle coal measures. I have seen an immense fragment attached to the roof of a cave near Louisa river, Ky. The locality of the large specimen of Prof. Hildreth is not mentioned on the labels. The small one is from Cannelton, Pa. The specimens described as *Caulopteris acanthophora*, in the Geol. Rept. of Ill., are from Colchester and Morris, Ill.

KNORRIA, *St.*

Trunks covered with elongated, semi-conical or truncate tubercles placed in spiral, more or less imbricated, leaving, after falling off, round convex marks, with a single vascular scar in the middle; leaves long, linear, more or less inflated at the base, with a flat medial nerve.

Of the specimens representing this genus I have seen only fragments with the persistent base of the leaves, like those of Atl., Pl. LXXIV, f. 14 and 15. The description of the leaves is made from Schp., Paleont. veget., II, p. 45.

Brongniart does not consider as reliable or positive the characters which separate Knorria from Lepidodendron, and Goeppert identifies many of the species of Knorria of authors with *Lepidodendron Veltheimianum.* It is certain that this *Lepidodendron* has sometimes, in a decorticated state, conical obtuse bolsters which are similar to those of Knorria. The same also is seen, less distinctly however, upon sub-cortical scars of *Sigillaria monostigma*, Atl., Pl. LXXIII, f. 6. But these deformations are casual, while, as remarked by Schimper and other authors, the peculiar characters of *Knorria* are traceable through the successive layers of the bark.

The species of this genus are rare in the American coal measures.

KNORRIA IMBRICATA, *St., Pl. LXXIV, Figs. 14 and 15.*

Lepidolepis imbricata, St., Fl. d. Vorw., I, p. 39, Pl. XXVII.

Knorria imbricata, St., ibid, p. 37. Goepp., Gatt., III, IV, Pl. I, II, f. 2, 4. Koech., Schlumb. and Schp., Terr. d. trans. d. Vosges, p. 332, Pl. XIII. Lesqx., Geol. Rept. of Ills. II, p. 457. Schp., Paleont. veget., II, p. 46. Heer, fl. d. Bären, Isl., p. 41, Pl. X, f. 3; XI.

K. longifolia, Goepp., Uebergsg., p. 199, Pl. XXX, f. 1, 2. Koech., Schlumb. and Schp., l. c., p. 333, Pl. XIV–XIX.

K. Schrammiana, Goepp., l. c., p. 201, Pl. XXX, f. 4. Koech., Schlumb. and Schp., l. c , Pl. XIII, f. b.

K. acicularis, Goepp., l. c., p. 200, Pl. XXX, f. 3. Heer, Foss. fl. d. Bären, Isl., p. 42, Pl. X, f. 6, 7.

Pinites pulvinaris and mughiformis, St., l. c., II, p. 201, Pl. XLIX, f 7, 5.

Diplotegium truncatum, Lesqx., Geol. Rept. of Arks., II, p. 311, Pl. IV, f. 1.

Tubercles of the trunks semi-cylindrical, conical, truncate, or obtuse; those of the branches small, papilliform, all closely imbricated.

Besides the synonyms quoted above, Schimper enumerates a number of others which show how uncertain are the determinations of the species of the genus. The two more notable forms remarked from American specimens are figured, one without leaves or decorticated, f. 14, with conical obtuse bolsters; the other, f. 15, with the base of leaves truncate, as they appear after their disruption from the stem. Other specimens have the bolsters shorter and more enlarged at the base, others have them acuminate and much narrower, referable to *K. acicularis*, Goepp.

An instructive specimen of this last species is a small stem, five and a half centimeters in diameter, flattened by compression to two centimeters in thickness, the scars in the middle of the stems being needle form, cylindrical, acuminate, about one centimeter long, nearly two millimeters thick, and five millimeters distant in the spiral direction. This part exactly represents *K. acicularis*, as figured by Goepp., Fl. d. Uebergsg, Pl. XXX, f. 3. On both sides of the stem, however, the scars disappear, first becoming shorter, more enlarged, convex, similar to those of *K. Schrammiana*, *Goep.* ibid., f. 4, and nearer to the borders they are effaced into concave small impressions, comparable to those of a small *Stigmaria*, or to those of f. 5, same plate described by Goepp. as *Ancistrophyllum Stigmariæformis*. When the upper coaly layer covering the scars of the specimens is taken out, the decorticated surface appears closely punctate like shagreen.

Another specimen in Mr. R. D. Lacoe's collection, nearly two meters in length, distantly dichotomous, forking twice in the whole length, thirty-five centimeters broad at its broken base and there flattened to ten centimeters in thickness, shows the scars more or less distinct, generally of the same shape as in Atl., f. 14. After erasion of the bolsters, the under-scars are small and oval. The same collection has a large number of finely preserved specimens of the same species, all variable in size and obtained from different localities around Pittston, where the vein of the Seneca Coal Company is worked. The same characters are remarked upon all of them, none showing any bolsters which could indicate a relation to *Lepidodendron Veltheimianum* or any other species of this genus.

Habitat—Sub-conglomerate coal of Ill., Mercer Co.; of Arks., etc. Lower coal strata in the Anthracite basin of Penn'a; Sharp mountain near Pottsville; Seneca vein F and Boston vein B, Pittston.

HALONIA, *Ll. and Hutt.*

Stems of medium size, dichotomous; cortex tuberculate; spaces intermediate to the tubercles marked with rhomboidal scars; decorticated surface covered with punctiform round or oval papillæ, obtuse or perforated in the center, placed in spiral order.

The relative characters of the plants of this division, and their appropriation, are still uncertain. The large tubercles, placed in quincunxial order, are, as seen by our specimens, either flattened and perforated at the top, or entirely covered, like the stems, with scars of scales or of leaves, and obtuse at the top, without trace of perforations. Some authors consider these tubercles as the inflated base of leaves and the papillæ of the surface as scars marking the points of attachment of scales. It is not well possible to understand the position of leaves distantly placed at the top of tubercles sometimes very large, while, as seen Pl. LXXXVII, f. 1, (this volume) the stems bear contiguous transversely rhomboidal scars like those of the leaves of *Ulodendron*, the buds or tubercles being covered with these scars, even to the top.

Mr. Binney, of Manchester, in his *Observations on the* *structure of fossil plants of the Carboniferous*, Part III, 1812, after reviewing the opinions of the authors on the nature of *Halonia*, p. 82 to 89, concludes his researches on the structure of the plants of this genus with the following remarks:

"I have always had a doubt that *Lepidodendron* had the *Stigmaria ficoides* for its roots, such as was proved to be the case with large ribbed and furrowed *Sigillariæ*. But I saw the probability of Mr. Dawes' views, that the *Halonia regularis* might prove to be the root of *Lepidodendron*, both on account of its frequent bifurcation, and on account of other characters quite independent of the similarity in structure of the two plants.

The researches of Mr. Richard Brown and of Prof. Schimper, led me to expect that *Lepidodendron*, as well as *Knorria*, had a stigmaroid root. My observations and the specimens here described, led me to conclude that *Halonia regularis* is the root of *Lepidodendron Harcourti*, but not the root of *Sigillaria*, that being, as before stated, *Stigmaria ficoides*."

Prof. Williamson, exposing the result of his researches upon the same kind of fossil plants, Manchester Phil. Trans., June, 1871, arrives at different conclusions, p. 225. 1st. That the projecting tubercles of *Halonia* were confined to the inner prosenchyma of the bark, but that they did not appear in any marked form, if at all, save as a scar upon the exterior of the plants."

2d. "That *Halonia* and *Ulodendron* are in close relationship, and that there is abounding proof that the tubercles had nothing to do with the ordinary branches of this plant; and that, therefore, nothing remains with which we can associate them, but strobiles. And with these, says the author, I believe them to have been connected."

Prof. Schimper, who had already briefly exposed the same opinion in his Paleont. veget. II, p. 52, reviews the subject again, (ibid., III, p. 541–543,) supporting especially his opinion on the character of a well preserved specimen of *Halonia* (*Cyclocladia*) discovered by Feistmantel, in Bohemia, as seen from the figure of a fragment in Schp.

loc. cit., Pl. CVIII, f. 11. The American specimen described below as *Halonia tuberculata*, is in a far better state of preservation as are also those from which the other species of *Halonia* have been established. They appear to represent the characters of these tubercles like those of the disks of *Ulodendron*, as being sometimes mere adventive buds of branches, or sometimes base of strobiles.

The vegetable fragments referable to *Halonia* are limited to the Carboniferous formations and represent few species in always scarce, rarely well preserved specimens.

I refer to this genus two species of an intermediate type uniting the characters of *Cyclocladia and Ulodendron.*

HALONIA TUBERCULATA, *Brgt., Pl. LXXIV, Fig. 9; LXXXVII, f. 1.*

Geol. Rept. of Ill., IV, p. 451, Pl. XXIX, f. 1. Brgt., Hist. d. Veg. foss., II, Pl. XXVIII, f. 1-3 (not described.)
H. regularis, Ll. and Hutt., Foss. fl., III, Pl. CCXXVIII.
Cyclocladia ornata (St.), Gold., flor. Sarræp., foss., I, p. 20, Pl. III, f. 11.

Tubercles large, disposed in quincunxial or spiral order at regular distance, button like, conical-obtuse, open, irregularly deeply grooved at the top, or more acute, entire and closed; leaf scars obscurely transversely rhomboidal; decorticated surface punctate.

The tubercles of our specimen are a little larger than those in Brongniart's figures, l. c., a result of the difference in the size of the branches. But the characters are exactly the same. The French author represents the top of the tubercles as irregularly pitted around the central part which in some of them is marked by a large round scar.

Halonia regularis, Ll. and Hutt., l. c., has the tubercles longer more acute and apparently closed at the top. The branches are also smaller and the size of the tubercles may correspond to that of the stems. It may be however a different species. But evidently *H. tortuosa* of the English authors is not identifiable to *H. tuberculata* of Brgt., which, like the American specimen from which my figure was made, represents the decorticated fragments of *Cyclocladia ornata*, Gold., l. c. Traces of scars of leaves are still seen on the right side of the stem, Atl., f. 9, near its base. They are transversely rhomboidal outlines, too obscure to give positive evidence of their attribution.

But the survey has recently obtained a most beautiful specimen of the cortex of this species with the leaf scars perfectly distinct. It is an impression into a very soft grained sandstone. A part of it is here figured from a cast made in order to have the tubercles in relievo and to more distinctly see the characters of the branch.

The tubercles, about two centimeters broad at the base, are button like, one centimeter high, truncate at the top into a circular smooth space one centimeter in diameter, hollowed into an obconical depression closed by a ring, two millimeters in diameter, surrounding a semi-globular papilla, perforated by a central point. In some of the tubercles the circular depressions or rings deepen to the center, making thus a central obconical cup without trace of perforations at its base. The intervals between the tubercles are not large, vertically one and a half centimeters, deeply marked by transversely rhomboidal leaf scars which become irregular on the side of the tubercles, but are perfectly distinct up to the circular flattened top which they surround. These leaf scars average five millimeters in diameter and two vertically. They are dotted in the middle of their smooth surface by a point or vascular scar. The deeply impressed borders between them are one millimeter broad.

The identity of this specimen, or of *Cyclocladia ornata*, Gold., to *H. tuberculata*, Brgt., as far at least as the species is represented by the author, l. c., Pl. XXVIII, f. 1, 2, cannot be doubted. For the fragments of cortex left upon the specimen of that f. 2 have the surface traced by enlarged rhomboidal leaf scars. F. 3, however, may belong to a different species. Though it may be, the specimen from Illinois which was described as *H. tuberculata?* Atl., Pl. LXXIV, f. 9, is identified with the one recently found in Penn'a, which is evidently the same as *Cyclocladia ornata*, Gold. The German author has also represented the leaf scars on a fragment of the bark on the left corner near the base of his figure, l. c. In this species the tubercles appear to represent the base of fruit or flower bearing cones.

Habitat—Sub-conglomerate coal measures, Chester co., Ill. The fine specimen mentioned above was found three miles south of Oil City, Venango co., Penn'a, at the base of the conglomerate sandstone. Communicated by Mr. H. Martyn Chance.

HALONIA TORTUOSA, *Schp., Pl. LXI, Figs. 1–2.*

Schp., Paleont. veget., (excl. syn.), II, p. 54, Pl. LXVI, f. 1 and 2. Eichw., Leth. Ross., I, p. 148, Pl. XI, f. 1-4.

Stems smaller; tubercles in quincunxial order or alternate in vertical rows, variable in distance, small, half globular, perforated in the center; cortex marked by transversely rhomboidal leaf scars (as seen in Schp., f. 1, 2, copied from Eichwald); surface under the cortex dotted by small round smooth papillæ.

The two figures of our plate represent both sides of the same specimen. It is a stem, three centimeters in horizontal diameter, flattened to two centimeters in vertical thickness, dichotomous, with branches in an open angle of divergence. The upper surface bears two parallel rows of tubercles, nearly alternate, one and a half centimeters distant, and the lower surface also two rows, placed near the borders, more distant, or a little more than two centimeters apart. This difference in the horizontal distance of the tubercles, the oval circumference of the stem, and the position of the tubercles near the borders on the lower side, which is nearly flat in the middle, prove that the stem has not been flattened by compression, but that it is in its original shape and that its natural position was not vertical but horizontal or prostrate, and that therefore we have here a fragment of a plant growing and expanding its branches upon the ground. The broad angle of their divergence already indicates this disposition.

This character seems to confirm the opinion of Binney on the nature of these plants which he regards as the roots of *Lepidodendon* or *Ulodendron.* But against this hypothesis, we have, as remarked by Schimper, the evidence of leaf scars covering the space between the tubercles. It is not necessary to consider these plants as roots, but as primordial stems, growing and expanding horizontally upon the ground. In this case, as *Stigmariæ*, which are the creeping primordial stems of *Sigillaria*, partake in their structure of some of the characters of this last genus, the primordial stems of *Ulodendron* or *Lepidodendron* might equally well as creeping stems represent the first mode of life of plants of these Genera, and have some of the characters which appear later more distinct and modified in erect or standing trees. The same consideration may be brought to mind in reading the description of the other fragments referable to this genus.

The tubercles of this species, as far as known, are not impressed with any traces of leaf scars. They are entirely smooth. The central vascular scar is very distinct; but remarkably enough, when the tubercles are partly or totally cut or destroyed by erosion, the round smooth surface left in their place is without point or trace of vascular scar. This is seen upon the specimen figured here as well as upon those represented by Eichwald. This fact might, per contra, explain the opinion of Prof. Williamson, which supposed that the tubercles were merely subcortical.

It is not possible to doubt that this species is the same as that described by Schimper and Eichwald, l. c. But *H. tortuosa*, Ll. & Hutt., II, Pl. LXXXV, is a different plant, rather referable to *H. dichotoma*, Gold. Flor. Sarræp., I, p. 20, Pl. III, f. 12, which has the leaf scars vertically rhomboidal, the branches nearly in right angle to the stems, or not really dichotomous, the tubercles in irregular position, all characters remarked in both Ll. & Hutt. and Gold. figures.

Habitat—The specimen, kindly communicated by Mr. Mr. Wm. Gifford, was found in a bed of sandstone toward the base of the coal measures, Peoria Co., Ills.

HALONIA (ULODENDRON) MANSFIELDI, *Sp. nov., Pl. LXVII, f. 2, 2a.*

Stem small, flexuous, dichotomous with diverging *branches; tubercles umbonate, ovate-obtuse, directed upwards, entirely covered with leaves, as seen by the impressions of their scars, which are broadly transversely rhomboidal, marked in the center by an oval mamilla surrounding a vascular point.*

That this fragment should be referred to *Ulodendron* rather than to *Halonia*, is possible. I am unable to decide. It has the leaf scars of *Ulodendron majus*, with a central mamilla and vascular scar like those of *U. commutatum;* but the tubercles are evidently buds of branches which cannot be compared to the disks of *Ulodendron*, and are rather like the tubercles of *Halonia*. These adventive buds of branches are about one centimeter long, nearly as large at the base, oblique to the main stem, marked with leaf scars to the top, which is without trace of perforation. The figure is copied from an impression of the stem, into pure Cannel coal. It has preserved all the details of the configuration as distinctly as if the specimen had been cast in plaster. The cavities of the surface are impressions of buds of the stems driven into the soft mould, and, of course, similar to those of the border. The stem is two and a half centimeters in diameter, half cylindrical, oval in its cross section, narrowed at the base, as are also the branches at the forking, wherefrom they gradually increase upward in thickness. The branch, diverging nearly in right angle, is short,. cut at its top into four unequal obtuse lateral lobes like buds or branchlets irregularly disposed.

Considering the whole fragment and its characters, it is scarcely possible to doubt that we have here, still more distinctly represented than in the former species, part of a creeping stem, or of a plant growing and expanding horizontally and flat upon the ground in the mud of the swamps. The adventive buds covered with leaf-scars, the irregular divisions of the lobes of the left branch, which resemble those of a rhizoma, cannot leave any doubt on the subject. The buds might represent sympodia upon these primordial stems, organisms which, continued and more fully developed, become fertile branches upon the fruiting or erect trunks of

Ulodendron and *Halonia*. I consider them in that way and believe, as said above, that we have here, not roots, but primordial stems, bearing to *Lycopodiaceæ* the same relation as *Stigmaria* bears to *Sigillaria*.

I have of this species a much smaller branch, only one and a half centimeters in diameter, a fragment in pyrite, with the scars and buds in relievo. It has the same characters as the large specimen. The buds or tubercles are not placed in regular order.

Habitat—Cannelton, Pa. Communicated by Mr. I. F. Mansfield.

HALONIA (ULODODENDRON) FLEXUOSA, *Gold.*, *Pl. LXI, Fig. 3.*

Ulodendron flexuosum, Gold., Flor. Sarræp., I, Pl. II, f. 10 (not described).

Stem small, flexuous between the tubercles, which are alternate and lateral; corticated leaf-scars vertically rhomboidal, represented under the cortex by oval, acute, small papillæ, each with a distinct vascular point.

The specimen which I refer to this species is a cylindrical branch two and a half centimeters in diameter and thus much smaller than the one figured by Goldenberg, which is eight centimeters broad. The characters seem however to be the same, at least from the position of the tubercles and the decorticated leaf-scars. In my specimen the top of the tubercles is conical, obtuse, without any central scar; while in Goldenberg's figure, it is represented as flattened, with a disciform cicatrice, like the disks of *Ulodendron*. This difference is probably caused by difference of age. The description of the leaf-scars upon the cortex is taken from Goldenberg's specimen, my own being entirely decorticated.

No description is made of the species by the author. He merely remarks in table of explanation of the plates, I, p. 37, that one sees, from the specimen figured, how the genus *Ulodendron* represents the forms of *Lepidodendron* by analogy of dichotomous divisions in the plants of both genera.

Habitat—Pittston, seen in Mr. R. D. Lacoe's collection, No. 582.

HALONIA PULCHELLA, *Lesqx., Pl. LXI, Fig. 5.*

Geol. Rept. of Arks., II, p. 311, Pl. III, f. 3.
Cyclostigma pulchellum, Schp., Paleont. Veget., III, p. 541.

Stem small, cylindrical; scars small, semi-spherical, close, in spiral order.

The stem is simple, thirteen millimeters in diameter, cylindrical, and of the same size in its whole length. The small half globular smooth tubercles, a little more than one millimeter broad, are separated by equal smooth intervals of about the same width. The branch bears in the middle a deep irregular nearly semi-lunar scar, of a character analogous to those of *Ulodendron punctatum* and may be a branch-scar.

Schimper refers this fragment to *Cyclocostigma*, a reference which seems to disagree on account of the large disk-like scar. *Halonia gracilis*, Ll. and Hutt., Foss. fl., II, Pl. LXXXVI, represents a simple stem of the same size, with leaf scars rhomboidal upon the cortex, and distant semilunar branch-scars, like the one marked on Atl., f. 5. The difference therefore is merely in the form of the leaf-scars which are apparently decorticated upon my specimen.

Habitat—Sub-conglomerate Coal measures of Arkansas, Male's coal bank, middle fork of White river. One specimen only.

HALONIA SECRETA, *Sp. nov., Pl. LXVII, Fig. 1.*

Stem of medium size; tubercles in regular spiral order, equidistant, transversely oval, covered with a thin hard convex smooth cortex; subcortical scars rhomboidal-oval, inflated on the borders, marked upon the central narrow depression by three round vascular points; surface of the stem smooth or irregularly dotted.

The fragment of stem, originally cylindrical, is thirty centimeters long, four and a half centimeters broad, reduced by compression to a thickness of about one centimeter. The tubercles are all of equal size, one centimeter in horizontal, eight millimeters in vertical direction. Their surface is a hard stony pellicle or bark, slightly convex, elevated in the center about two millimeters above the borders, smooth like the stem, which is merely irregularly dotted by distant points or small rugosities. Under the cover or upper layer of bark of the tubercles, there is a deep cavity generally filled with carbonaceous powder easily taken out, and the bottom is a broadly transversely rhomboidal scar inflated on the borders (f. 1*a* enlarged), dotted with three vascular points like those of the inside scars of *Lepidodendron*. The disposition of the scars is perfectly concordant in the whole length of the stem of which the part figured is merely a fragment; their distance is also exactly the same, about one centimeter from center to center in the direction of the spiral in 5—11.

I do not know indeed to what group of the *Lycopodioceæ* of the coal this plant or stem is more positively referable. The tubercles have somewhat the form of those of *Halonia;* the subcortical scars resemble, as seen above, the inside scars marking the point of attachment of leaves of *Lepidodendron;* but they are not on the surface, the hard cortical layer covering them all being evidently part of the plant and truly organic; hence we have here a kind of stricture which might represent a rhizoma with some of the organs of the plants in an adventive undeveloped state. This confirms Prof. Williamson's opinion exposed above that the projecting tubercles of *Halonia* were confined to the inner parenchyma of the bark, as seen in the fragment or species which he had for examination.

Habitat—I owe the communication of the specimen figured to Mr. Wm. Gifford. It was found with other fragments of the same plant above coal vein No. 6, Peoria co., Ill.

LEPIDOPHLOIOS, *St.*

Lomatophloios, Corda, ex parte.

Stems arborescent, erect, with four ranked branches disposed in spiral order; leaves coriaceous, linear, long and narrow, with a thick medial nerve, bearing at base thick suberect or recurved bolsters inflated in the upper part *and dotted with small vascular points. Leaf-scars transversely rhomboidal, marked horizontally by three vascular scars, minutely papillose under the cortex.*

The specimens of this genus obtained until now from American coal measures are rare and not well preserved, none of them with leaves. I have therefore copied the above diagnosis from Schimper, (Paleont. veget., II, p. 49,) who has had for examination the splendid materials representing this genus, obtained and partly figured and described by Goldenberg, Fl. Sarræp., III, p. 25–40, Pl. XIV–XVI.

From the remarkable works of this last author is derived the following elucidation: The plants of this genus differ from those of *Lepidodendron* by a four ranked ramification; by very thick foliaceous appendages or bolsters, open or turned backward, so that the leaf-scars appear to be placed at the lower part. These appendages, inversely imbricated, were apparently thick or succulent with a coriaceous epidermis. In most of the specimens especially in those which are flattened by compression, this epidermis is preserved in the form of transversely rhomboidal scales, irregularly cut on the borders, imbricated downward from top to base and marked in the middle by a small round or triangular scar (Atl. Pl. LXVIII, f. 2, 9*a*), often erased. It is on this mode of preservation that Sternberg has established his genus. Corda has seen a generic character in the persistence of the foliaceous bolsters remaining entire in one of his species and on this based his genus *Lomatophloios* to which the genus *Pachyphlæus*, Goepp., syst., p. 433, Pl. XLIII, is also referable.

Corda considers the transversely ribbed cylinders described under the name of *Artisia* or *Sternbergia* as the medullar axis of *Lomatophloios* or stems deprived of the vascular envelope. Prof. Williamson has observed the same kind of organism in stems of *Dadoxylon* and Prof. Dawson in those of Devonian conifers. It will be seen, in the description of *Cordaites* that transversely ribbed cylinders of the same characters also represent the central axis of these plants. I have never found any specimen of *Artisia* in connection with plants of other vegetable groups of the Coal measures than *Cordaites* and have described them with this genus, Atl., Pl. LXXIX, f. 3. Grand'Eury has also seen them and abundantly with the same plants.

I have figured and described here the scars on the bark of *Lepidophloios* with the scales turned down or below the impression of the leaf scars as they are generally seen upon the fragmentary specimens which I have had opportunity to examine.

LEPIDOPHLOIOS CRASSICAULIS, *Corda.*

Lomatophloios crassicaulis, Corda., Beitr., p. 18, Pl. I–V. St., Fl. d. Vorw., II, p. 206, Pl. LXVI, f. 10–14; LXVIII, f. 20. Gold., Fl. Sarræp. foss., III, p. 26, Pl. XIV, f. 7–24.

Lepidophloios crassicaulis, Heer, Fl. foss. Helv., IV, p. 40, Pl. XXI, f. 2 (medullar cylinder). Stur, Culm. fl., p. 337, Pl. XIX, f. 2 (bolsters and leaves). Schp., Paleont. veget., II, p. 50, Pl. LX, f. 13, 14.

Zamites Cordai, St., l. c., p. 196, Pl. LV.

Tithimalites biformis, St., ibid, p. 205, Pl. LIII, f. 1–6 (medullar cylinder).

Sternbergia approximata, Brgt., Prodr. (medullar cylinder).

Bolsters of the base of leaves elongated, persistent, imbricated; leaves long, linear, acute, carinate on both sides, or, in the cross section, transversely rhomboidal or alate; scars rhomboidal, narrowed and elongated to the base.

I have not seen the leaves of this species. The specimen which I describe represents the bolsters, base of the leaves and the stem. These bolsters are exactly as figured by Corda, Sternberg and Schimper, loosely imbricated, obscurely rhomboidal-oval, cut or emarginate at the top by the base of the leaf-scars. The stem is corticated, five centimeters broad; the cortical cylinder, about one centimeter thick, covers the upper part of the specimen, while destroyed as it is on the lower part, the internal cylinder is there exposed in its whole length. The decorticated surface is marked by obscurely rhomboidal inflations, corresponding in position to that of the leaf-scars, and is irregularly wrinkled lengthwise, like the stem f. 2*a* in Corda, loc. cit., which however has no trace of rhomboidal leaf-scars.

Now this central cylinder is flattened to one centimeter in thickness and does not show trace of any other internal subdivision or pith, the whole being compact clay-shale as composing the true medullar cylinder. Therefore if I have to rely on the characters of this specimen, the transversely ribbed cylinders referred by Corda to *Lomatophloios* and after him by the authors (except Sternberg), do not belong to the genus. Corda has described, Pl. V, a stem whose outside characters, leaf scars, etc., are not marked and which may represent a different kind of plant. Sternberg, l. c., describes and figures three transversely ribbed stems as *Tithimalites biformis*, l. c. Goldenberg describes and figures them from stems which he considers as those of *L. crassicaulis* all of them however without the supercortical organisms, leaves or bolsters. Neither Heer, Stur, nor Grand 'Eury say anything on the subject. It would indeed be remarkable if *Lomatophloios* which by the characters of the fructification is evidently referable to the *Lycopodiaceæ* should have an internal structure similar or analogous to that of the *Cordaites* which as seen by their fructifications are evidently of a far different class of plant.

Habitat—My specimen is from the roof shale of Morris, Ill., kindly presented by Mr. S. S. Strong. The internal cylinder generally referable to this species is rare in our coal measures, except at Cannelton, Pa., as pith of *Cordaites*. A specimen in the Museum of Comp. Anatomy of Cambridge, L. 23, is from Carbondale; another in Mr. R. D. Lacoe's cabinet is from Pittston. I have received one also from Montevallo Coal mines, Ala. (subcarboniferous) by Mr. T. H. Aldrich, and seen one in the collection of Mr. Gurley of Danville, Inda., locality not indicated. No remains of *Artisia* have been found at Morris or Mazon Creek, where specimens with bark and leaf-scars of *Lepidophloios* have been found, and no fragment of bark of species of this genus has been obtained from Cannelton where *Artisia* specimens abound.

LEPIDOPHLOIOS AURICULATUS, *Lesqx., Pl. LXVIII, Fig. 3.*

Geol. Rept. of Ill., IV, p. 439, Pl. XXX, f. 1. Schp., Paleont. veget., III, p. 537.

Scales large, thick, broadly rhomboidal in outline, round-

ed in both the upper and lower part, imbricating on the borders, very smooth; leaf-scars transversely narrowly rhomboidal and acuminate on the sides, obtuse at the top, angular at the base.

The bolsters (taken altogether) measure three centimeters laterally and two and a half from the base. The leaf-scars are comparatively narrow, one centimeter wide laterally and only three to four millimeters in vertical direction, with the vascular point mostly indistinct. These large bolsters are often found separate, always preserving with the leaf-scars their forms and relative position. It is therefore difficult to understand them as composed of an impression of the base of leaves represented by the top leaf-scar, with overturned scales which, as seen in the splendid figure of Goldenberg, originally attached as horizontal to the scars, have been turned back and compressed. This however has nothing to do with the characters described.

This species is much like the large scars of *L. laricinus*, St., in Gold., l. c., Pl. XVI, f. 1, from a specimen which this author considers as derived from the base of a large trunk. The scales of the American species are broader, shorter, more obtuse at the base.

The name of *L. auriculatus* was given to this species on account of a *Lepidophyllum* (blade and sporange), which I considered referable to the same plant, as it was found associated with the large scales, as seen Geol. Rept. of Ill., Pl. XXIV, f. 1, which represents fragments of *Lepidodendron Tijoui*, one separate bolster of this *Lepidophloios*, and a *Lepidophyllum auriculatum*. I remarked in the first description, l. c., that this might be a fragment of a large cone.

Habitat—Shale of the coal of St. John, Ill.

LEPIDOPHLOIOS LARICINUS, *St.*

Gold., Flor. Sarræp. foss., 3, p. 30, Pl. III, f. 14; XV, f. 11–13: XVI, f. 1–8. Schp., Paleont. Veget., II, p. 51, Pl. LIX, f. 4; LX, f. 11.

Lepidodendron laricinum, St., Fl. d. Vorw., 1, p. 23, Pl. XI, f. 2, 3, 4.

Halonia punctata (Ll. & Hutt.), Gein., Verst., p. 38, Pl. III, f. 16. (fide Schp).

Lepidophyllum majus, Brgt., Prodr. (fide Gold.)

Scales compressed; bolsters transversely oval (including *the leaf-scars), narrowed and acute at the sides; leaf-scars small, of the same form, marked with three distinct vascular points.*

The characters of this species are so very diversified, according to the parts of the stem represented by the specimens, either as corticated or subcorticated, or according to the more or less complete compression of the scales and their more or less integrate preservation, that it is very difficult to give a clear definition of it. The American specimens referred to it are mere fragments, and so deficient that I cannot positively say if any of them truly represent the species. These fragments have the bolsters (scales and leaf-scars) smaller than those of Atl., Pl. LXVIII, f. 2; the scales distinctly carinate in the middle; the leaf-scars more definitely rhomboidal, measuring vertically three to five millimeters, and laterally five to seven. The four angles are distinct, not rounded, the lateral ones more acute or acuminate. The leaf-scar is marked by three vascular points in horizontal line, and the scales elongated and acute at the lower end.

Habitat—Shale of the Morris coal, not rare, (bark and bolsters); over Jackson's shaft coal, Ohio, Prof. E. B. Andrews. Pittston, Pa., Mr. James. An obscure specimen from the subconglomerate coal of Alabama, is referable to this species, or to *L. macrolepidotus*. This form is represented in the State Cabinet of Ill. by specimens from Mercer county, also subconglomerate.

LEPIDOPHLOIOS OBCORDATUS, *Lesqx.*

Geol. Rept. of Ill., II, p. 457, Pl. XLI, f. 1, 2? Schp., Paleont. Veget., II, p. 52.

Bolsters (base of leaves) linear, slightly enlarged to the broadly rhomboidal point of attachment, carinate in the middle; decorticated scars subcordiform in their natural overturned state, rounded on the sides and base, overtopped by a button-like small mamilla corresponding to the leaf-scars, distant.

The scales are seven millimeters broad at the lower part, where they become narrower in rounding to the point of attachment five millimeters, where they are broken, twelve millimeters from the base, distinctly carinate, punctulate on the surface. The decorticated scars are only five millimeters in vertical direction, including the top mamilla, and seven millimeters wide horizontally.

I referred with doubt to the same species a corticated fragment, f. 2, which bears large rhomboidal impressions twelve millimeters broad, seven millimeters vertically, with a small mamilla at the upper angle; the sides are acute, the lower border obtuse or half round.

The reference is uncertain, as the specimen seems to represent a corticated fragment of the former species, much like the one in Schp., Paleont. Veget., Pl. LIX, f. 4.

Habitat—Duquoin coal, Ill.; same horizon as the St. John's coal.

LEPIDOPHLOIOS MACROLEPIDOTUS, *Gold.—Pl. LXVIII, Fig. 2.*

Gold., Flor. Sarræp., III, p. 37, Pl. XIV, f. 25. Schp., Paleont. Veget., II, p. 52.

Bolsters imbricating at the base, a little tumescent, obtusely curved on the sides; leaf-scars transversely rhomboidal; vascular scars three, the middle one somewhat lower; scales marked in the middle by a small round mamilla.

The bolsters are one and a half centimeters, from side to side, and a little more than one centimeter vertically including the leaf-scar, rounded in the upper part, elongated and acuminate to the base. The leaf-scars are narrow, four millimeters vertically, eight to nine millimeters transversely, rather oval, narrowed and acuminate at the sides.

There is scarcely any difference between the characters indicated by our figure and those in Goldenberg's. The bolsters are slightly smaller and less inflated in the American specimen.

Habitat—It is represented by a fragment, No. 117, in Mr. Gurley's collection. Grape creek, Ill.

LEPIDOPHLOIOS SIGILLARIOIDES, *Sp. nov.*, *Pl. LXVIII, Figs. 8, 8a.*

Scars distant, rhomboidal, acute at the top and the sides, the base rounded; vascular points simple, conical, marked in the middle of the lower border of the leaf-scars.

This may represent merely the leaf-scars of a decorticated specimen. The surface of the fragment is smooth, the scars or bolsters distant, one centimeter broad, six millimeters vertically. The bolsters are divided into two parts by a deep curved line, parallel to the lower border, which forms a small leaf? scar, two millimeters high, five broad, with a single conical vascular scar placed in the middle of the line. If this small rhomboidal top scar represent that of a leaf, the lower part would be the scale, and of course the figure like the others of this species, should be seen overturned. No species of this genus is represented with bolsters as distant. Except this, the characters refer the fragment to a *Lepidophloios*.

Habitat—Clinton, Mo. Communicated by Mr. I. H. Britts.

LEPIDOPHLOIOS PROTUBERANS, *Lesqx.*, *Pl. LXVIII. Figs. 9, 9a.*

Geol. Rept. of Ill., IV, p. 440, Pl. XXVI, f. 1 and 2. Schp., Paleont. veget., III, p. 537.

Cortex thick, striate lengthwise; scars marked upon it by a thick protuberance of coal like a proboscis; bolsters (decorticated) ovate, enlarged below the middle, narrowed downwards to a truncate acumen; leaf-scars rhomboidal, rounded at the base, mamillate under it, acute at the sides, more prolonged and acuminate to the top; vascular scars three; the middle one a little higher, with a small triangular scar above it.

Since the first description, l. c., I have had opportunity to see other specimens of the same species. Except that sometimes the cortex is deprived of the button-like protuberances, from which the species was named, the essential characters are marked upon all. The bolsters are rarely seen in their integrity, being often half imbedded into the stone, and the upper part covered by coal or other inorganic matter. F. 9*a* represents them in a good state of preservation. The scales measure, in the more enlarged part below the middle, one and a half centimeters and are hence rapidly contracted downward into a short truncate cauda. From its extremity to the round base of the leaf-scar, they are one and a half centimeters in vertical line, and the scars half a centimeter in the same direction. The mark above the three vascular points is a triangular impression, rarely distinct. From the mamilla under the leaf-scars there is a smooth circular expansion from which diverge narrow wrinkles flabellate to the borders. These also are rarely distinguishable.

Habitat—Shale of the coal at Morris, Mr. S. S. Strong; not rare there, but not found elsewhere.

LEPIDOPHLOIOS ICHTHYODERMA, *Sp. nov., Pl. LXVIII. Fig. 10.*

Tubercles distant, umbonate, broadly transversely oval, marked with a small rhomboidal top or central scar, surrounded at the base and on the sides by linear truncate deciduous scales.

The relation of this fragment is very uncertain. It should perhaps have been described with *Halonia*, as by its broad oval scar it has some likeness to *H. secreta*. I was at first disposed to omit its description, supposing that it might represent the scaly skin of some fish. But the regular spiral order of the convex tubercles is against this supposition. The oval tubercles, two centimeters in diameter on one side and one and a half on the other, are somewhat distant, half a centimeter in the direction of the spiral, slightly convex, mammillate in the center, covered on the sides with linear truncate scales, two to three millimeters broad, half a centimeter long, which, either glued on the borders or free, appear to become separated from the disks and reflexed backwards, leaving their scars upon the disks and covering the intervals. The characters, as seen upon the specimen which is very distinct, are exactly represented in the figure. This might be perhaps the corticated state of a species of *Ancistrophyllum*, Goepp.?

Sturr, in Culm Flora, Pl. XXIII, f. 5, has figured a fragment which seems to belong to the same kind of vegetable organism. It bears upraised mamillæ much smaller than those of our specimen, but the difference is, as in all the species of *Lepidodendron*, merely of age. The small bolsters, five to six millimeters in diameter, exactly circular, appear covered on the sides by linear scales or their impressions. They are mostly and irregularly truncate at the top, some of them bearing three vascular scars in irregular position. On his specimen, which Dr. Sturr places with *Lepidodendron Volkmannianum*, he remarks, l. c., p. 291: "As an addition to *L. Volkmannianum*, I have figured a very remarkable *Lepidodendron*, which is too fragmentary to allow me to describe it as a new species. The bolsters, separated by *S* shaped rugose continuous furrows, bear upon a round mamilla, an irregular small flat surface marked by three vascular points. The leaf scars are finely pitted, the medial line is under the vascular scars and generally short, rounded, etc."

The peculiar character of the elevated mamilla is not remarked upon. I believe that in comparing both the figure of the Atlas and that of Dr. Sturr, l. c., the analogy even identity of characters will be fully recognized. My specimen is a fragment of bark of an old stem. The top of the bolsters represent leaf-scars, the vascular impressions have been totally erased or covered up by the compression of the borders.

Habitat—Roof shale of Morris coal; communicated by Mr. S. S. Strong.

FRUCTIFICATIONS OF LEPIDOPHLOIOS? *Pl. LXVIII, Figs. 1, 6, 7, 7b.*

Agglomerations of spores at the base of imbricating large blades, attached to broadly rhomboidal upraised tumescent scars; spores covered either by the base of the blades, but more probably by a kind of indusium glued to *their under side; blades or bracts oblong, narrowed at the point of attachment, apparently long, lanceolate, with a broad medial nerve; spores large, one millimeter in diameter, agglomerated together without apparent order of disposition, easily detached in groups, circular, with an inflated border when compressed, or generally globular on one side, triangular on the other, the lines of the angles being distinct though somewhat effaced by compression.*

The specimen shows only what is represented, f. 6. F. 7 is from another specimen without blades, but exposing the imbricate position of the agglomerations of seeds more distinctly than in f. 6.

There is a great deal of uncertainty in regard to the fructifications of *Lepidophloios.* In Fl. Sarræp., 1, p. 21, Pl. III, f. 13, 13*a*, 13*b*, Goldenberg describes *Lepidophloios lepidophyllifolius*, with imbricate large leaves, which he considers as stem leaves, remarking that they are the same as those formerly known under the name of *Lepidophyllum majus*, Brgt. In III, Pl. XV, f. 5, the same author considers these organs as sporanges and blades of cones of *Lepidophloios laricinus.* They are of the same type as those of our Pl. LXIX, f. 34 and 37. F. 13*a* of Goldenberg, quoted above as representing leaves of *L. lepidophyllifolius*, is scarcely different from that of Roehl, foss. fl., Pl. XIII, f. 1*a* and 1*b*, described as fruits or strobiles of *Lepidophloios laricinus.* A part of it is copied Atl., Pl. LXVIII, f. 1. By comparing it with f. 6 of the same plate, it will be seen that the blades have the same character; but those of f. 6 cover agglomerations of macrospores imbricated under the base of the leaves. From this it seems that the sporanges with large blades in Gold., l. c., Pl. XV, f. 5, which the author considers as identical with *Lepidophyllum majus* of Brgt., and at the same time as fructifications of *Lepidophloios laricinus*, are not truly referable to *Lepidophloios*, or that at least this reference is uncertain. The same may be said perhaps of the fragment Pl. LXVIII, f. 6. But I do not see to what other genus of the *Lycopodiaceæ* it could be referred, and for this reason I describe it as fruit of *Lepidophloios*, apparently identical with f. 1, of the same plate, but not with Goldenberg's figure of *L. laricinus.*

Sporanges joined to their blades, found disconnected from the cones, and without evident relation to strobiles, are described as *Lepidophyllum.*

Habitat—Cannelton coal. Mr. I. F. Mansfield.

CYCLOSTIGMA, *Haugton.*

Stems arborescent; surface tuberculate, rugose lengthwise; tubercles in regular spiral order, small, subglobose, more generally conical acute, topped with a vascular terminal and prominent point, or more rarely flattened at the top into small round areoles with the vascular point in the middle; decorticated surface smooth or obscurely striate lengthwise by the series of tubercles which are oval, elevated or prominent and gradually effaced downward or decurring, preserving the impressions of the central vascular scars.

CYCLOSTIGMA KILTORKENSE, *Haught.*

Annal and Magaz. of Natur. Hist., 3d series, v. V, p. 444. Heer, foss. fl. d. Bären Isl., p. 43, Pl. XI.

The specific characters are the same as for the Genus.

The characters of the tubercles of the corticated surface, recognized upon American specimens, are in concordance with those indicated by the description and fine figure of this species in Heer, l. c., the tubercles being perhaps slightly larger, four millimeters in diameter, and more generally conical than areolate at the top. The difference is of no moment, for the acute top of the tubercles is formed of a coaly layer, apparently fragment of the base of the leaves remaining attached to the tubercles, which are also of various size in the different specimens figured by Heer, all referred to the same species. The under or decorticated surface has the tubercles tumescent or elevated above the surface, oval, one millimeter broad, three millimeters long, prolonged and effaced downward. Prof. Heer remarks that the elongated tubercles of *Knorria* are not seen under the bark of this genus. Indeed the oval scars are not those of a *Knorria,* though by the prolonged tumescenses in effacing downward they have somewhat the appearance of obscure forms of this genus. The difference is however easily remarked, as the more gradual prolongation of the scars traces upon the surface narrow ridges like obscure striæ. Moreover, these scars always bear a distinct central vascular point. The two specimens examined, parts of a flattened stem, sixteen centimeters in diameter, do not bear any remains of leaves or of peculiar organs referable to *Lycopodiaceæ*, like the leaves figured by Heer as probably pertaining to this species. The cortex is covered by a prodigious quantity of shells of *Spirorbis carbonarius*, Daws., larger than I have seen them elsewhere.

Habitat—Near the base of the middle Carboniferous measures, in a kind of hard calcareous clay (bastard limestone), with a profusion of pinnæ of *Neuropteris rarinervis*, leaves of *Cordaites* and stems of *Calamites ramosus*. The plant is therefore, in America, a Carboniferous species. It has been found in England in the old red sandstone, Catskill group.

Habitat—Near Alta, Peoria co., Ill., communicated by Mr. Wm. Gifford.

Dechenia, Goepp.

Stems arborescent; leaf-scars in continuous spiral lines; bolsters oblong, rounded, marked by obscure concentrical striæ on the middle of which were attached leaves probably cylindrical.

This description is translated from Goeppert, Gatt., II, III, p. 43, and I must say, comparing it with the figures for the description of which it is made, that it does not give a satisfactory account of the characters of the fragments which they represent. *D. Euphorbioides*, Goepp., l. c., Pl. III, f. 1, represents a piece of bark covered with very irregular bolsters, not merely of various size, but oval or round or elongated, turned in various ways, even crosswise and without any trace of a central scar. Only some of them have on their back an excrescence rarely concentrical. The other figures 2 and 3 of the same plate, show an agglomeration of round or oval inflated bladder-like tubercles, whose relative disposition is as variable as their shape. The bolsters of the specimen represented Atl., Pl. LXVII, f. 3, which I have named *Dechenia striata*, are larger, quite as irregular in relative position and size than those of Goeppert, f. 1; the shape is about the same. Rounded and inflated in the lower part, irregularly superposed or imbricate, regularly striate lengthwise, they are without any trace of leaf-scars or points of attachment of leaves. This fragment is quite as incomprehensible in its relation and as remarkable as that described above as *Lepidophloios ichthyoderma*. Schimper considers the *Dechenia*, species of Goeppert, as referable to *Ancistrophyllum*, another genus of a very uncertain character. Possibly the remains, described under this generic name are mere ferruginous concretions.

Habitat—Black band iron ore, near Alta, Peoria co., Ill., Mr. Wm. Gifford.

LEPIDOSTROBUS AND LEPIDOPHYLLUM.

Strobiles cylindrical or ovate, oblong, conical, variable in length, composed of sporanges (spore cases) subcylindrical or clavate, emarginate at the apex, supported in the middle lengthwise by bracts formed of a pedicel attached like the sporanges in right angle to the axis, linear or oblanceolate, either simple, not longer than the sporanges or prolonged into lanceolate obtuse or acuminate laminas, curved upwards on the outside of the strobiles and imbricated on their sides, or merely inflated at the outer end and covering the apex of the sporanges by a rhomboidal small shield; spores triquetre on one side, half globular on the other, like those of the Lycopods, homomorphous or dimorphous.

Without taking into account the anatomical details of the structure of the strobiles (*Lepidostrobus*)* which can be studied only from silicified specimens and by the work of the lapidary, we recognize in the cones of *Lepidostrobus* a central axis, Atl., Pl. LXIX, f. 1–2, to which are attached in right angle the sporanges of various forms, supported by a long linear pedicel. The sporangiophores are either short and not passing out beyond the apex of the sporanges, as in Pl. LXIX, f. 10, or prolonged on the outside, where they enlarge at the apex of the sporanges into a kind of shield, ibid., f. 8, or continued as the medial nerves of blades (*Lepidophyllum*) of various forms, mostly linear or lanceolate, acuminate, f. 34–40, etc., or oblong obtuse, f. 29, 31, 33. The sporanges united to their supports and generally left attached at the base of the blades, are seen also of various length and shape in the same figures, either oblanceolate or wedge form, truncate or emarginate at the point of union to the blades, etc.

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* Dr. Hooker, as botanist of the Geological survey of Great Britain, has published in the memoirs of the survey, Vol. II, p. II, p. 387–456, an admirable description with figures of the structure of *Lepidostrobus*. The characters of the organism are there exposed with a lucidity and beauty of illustration which cannot be surpassed. The Atlas of Shimper, Paleont. Veget., Pl. LXI and LXII, represents the more important of the characters observed by microscopical analysis.

Prof. Schimper, Paleont. Veget., II, p. 60, describes the spores as *microspores*, united or agglomerated by four, tetrahedral, very small, not perceivable by the naked eyes, not larger in diameter than the fiftieth of a millimeter, and *macrospores*, those of the same form as described above, Pl. LXIX, f. 9*a*, large enough to be seen without a magnifier, not less than half a millimeter in diameter, often as large as one millimeter or more (ibid., f. 11, 12, etc.) Those of this kind only are described in this work as spores. I have observed the microspores on a single specimen of *Lepidostrobus*, only.

Sometimes, after dehiscence of the blades, scars of their base, of a transversely rhomboidal shape, are left upon the strobiles which, when flattened, resemble fragments or short branches of *Lepidodendron*.

LEPIDOSTROBUS GOLDENBERGII, *Schp.*

Paleont. Veget., II, p. 61, Pl. LXI, Brgt., Hist. d. Veget. Foss., II, Pl. XXIV, f. 6.

Strobiles large, bracts lanceolate, acuminate, half open; axis comparatively narrow; sporanges long, in right angle.

The American specimens referable to this species are mostly fragmentary; one only is preserved whole. It is cylindrical, thirty-three centimeters long, four and a half to five centimeters broad between the base of the blades, with an axis eight to ten millimeters. The blades or bracts, two and a half centimeters long, are half open, curved inward, four to five millimeters broad at the base which is carinate by a broad double nerve generally indistinct. The scars upon the cones, when the blades are detached, are transversely rhomboidal.

The size of the strobiles is like that of the fragment figured by Schimper; but the blades are somewhat shorter. The strobiles are exactly cylindrical, abruptly rounded or nearly truncate at the top.

Habitat—The fine specimen described here is from Cannelton, found by Mr. I. F. Mansfield. Another, broken in the middle, in the cabinet of Mr. R. D. Lacoe, is from Oliphant. The museum of Comp. Zool., Cambridge, has two specimens from Mazon Creek, L. 36 and 37, which are finely preserved but not in their integrity. The species is rare.

LEPIDOSTROBUS PRÆLONGUS, *Sp. nov.*

Strobiles very long, comparatively narrow; sporanges linear, inclined upward; blades narrow, linear or lanceolate-acuminate.

The only fragment seen of this fine species is twenty-five centimeters long. From the statement of the owner the strobile was seventy-eight centimeters long to the point where it was broken, and part of it remained still imbedded in the slate. The axis averages one centimeter in diameter, being larger toward the base; the sporanges inclined upward, are one and a half centimeters long; the bracts, half opened, are on the same angle of divergence as the sporanges, narrower, three to four millimeters broad at the base, four to five centimeters long, gradually narrowed up to a sharp thin acumen, with the double broad midrib of *Lepidophyllum.*

The oblique position of the narrow sporanges remaining the same in the whole length of the strobiles, the form and size of the blades, narrower and longer, and the great length of the strobiles, separate this species from the former.

Habitat—Near Pittston, Everhart's colliery, C vein; specimen No. 556 of Mr. R. D. Lacoe's collection.

LEPIDOSTROBUS PRINCEPS, *Lesqx.*

Geol. Rept. of Ill., II, p. 455, Pl. XLV, f. 1-4. Schp., Paleont. Veget., II, p. 65.

Strobile large, cylindrico-conical; axis narrow; sporanges oblanceolate; blades short, lanceolate, acuminate.

This, like the former species, is related to *L. Geinitzii*, Schp., as figured in Gein., Verst., Pl. II, f. 1, 3, 4, from which it seems however to differ by the small axis, the shorter sporanges and the erect loosely imbricate blades enlarged and emarginate at their point of attachment to the sporanges. The cone is twenty to thirty centimeters long; the blades two to five and a half long, eight millimeters broad at the base, marked by a broad double medial nerve.

This species cannot be identified to *L. variabilis* of Ll. and Hutt., though it may be a variety of *L. Geinitzii*, Schp., a form referred by Geinitz to *L. variabilis*, Verst., l. c., p. 35.

Habitat—I found this species at Duquoin, Ill. If the strobile is that of an *Ulodendron* it should be referable to *U. elongatum*, whose leaf-scars have the same characters, but certainly not, as Schimper supposes, to *U. minus*, which as yet is for America a subconglomerate species.

LEPIDOSTROBUS VARIABILIS, *Ll. and Hutt., Pl. LXIX, Fig. 26.*

Ll. and Hutt., Foss. fl., I, Pl. X, XI. Schp., Paleont. Veget., II, p. 61, Pl. LVIII, f. 2a, 5; LXI, f. 1, 2.

Cones of medium size, cylindrical or conico-cylindrical; sporanges in right angle; bracts narrow, lanceolate-acuminate, closely imbricated and appressed.

From the figures given of the species by European authors, it seems evident that different kinds have been described under this common name. The few American strobiles which I have considered as representing it, are not cylindrical, but narrowed to the apex or conical. The blades are generally crowded, closely imbricate, about one centimeter long, narrow, nearly linear or scarcely enlarged at the base, where they measure one and a half millimeters in width. The strobiles vary from two to three centimeters in diameter when flattened, and from seven to fourteen centimeters in length.

Habitat—The cabinet of Mr. R. D. Lacoe has a sub-cylindrical specimen from Oliphant. Another, that of f. 26, is in the same cabinet under No. 305, with a few others of the same type, scarcely variable in shape and size. The species is rare in the American coal measures.

LEPIDOSTROBUS SPECTABILIS, *Sp. nov.*

Cone large, linear-oblong, rounded at base to the axis, obtuse at the top; axis comparatively narrow; sporanges long, in right angle to the axis; blades short, narrowly lanceolate, acuminate, appressed and closely imbricated.

The cone described under this name is the best preserved strobile I have seen from the coal measures. It is forty centimeters long, five centimeters broad in the middle, gradually decreasing upward where it measures, at the obtuse top, three centimeters in diameter, and to the base, where it is three and a half centimeters broad, there rounding to an axis one centimeter in diameter. The blades are short and narrow, one and a half centimeters long and two millimeters broad at the base, point of union to the sporanges covered by the close imbrication of the blades.

Considering the shape of the cone and the size of the appressed blades only, this splendid cone could be considered as a variety of *L. variabilis;* but its great size is against this reference. The blades also are not as thick or coriaceous as in *L. variabilis;* not as closely compressed against the cone and though the medial nerve is distinct, it is not as thick, and the bracts are not carinate on the back.

Habitat—I have two specimens of this fine species both received through the kindness of Mr. I. F. Mansfield. The one not described is a little narrower, not as much enlarged in the middle and apparently longer, for its lower part is broken, and the preserved fragment is thirty-seven centimeters long.

LEPIDOSTROBUS LANCIFOLIUS, *Lesqx., Pl. LXIX, Figs. 30, 30a.*

Geol. Rept. of Ill., IV, p. 442, Pl. XXXI, f. 7. Schp., Paleont. Veget., III, p. 544.

Cones narrow, cylindrical?; sporanges very short, triangular; blades linear in the lower part, slightly enlarged to the point of attachment, lanceolate from above the middle and sharply acuminate, convex or carinate, thick; medial nerve distinct, inflated.

A mere fragment with bracts of a peculiar form, two and a half centimeters long, five millimeters broad below the middle where they are a little narrower than at the base and under the apex; sporanges short, four millimeters long, enlarged to five millimeters at the point of attachment. The cone, judging from the fragment, is about one and a half centimeters in diameter. The form is intermediate between that of the former and of the following species.

Habitat—Concretions of Mazon Creek.

LEPIDOSTROBUS LANCEOLATUS, *Brgt., Pl. LXIX, Fig. 38.*

Lepidophyllum lanceolatum, Brgt., Prodr., p. 87. Ll. and Hutt., Foss. fl., I, Pl. VII, f. 3-4. Lesqx., Geol. of Penn'a (1858), p. 875, Pl. XVII, f. 1 (cross section of a cone).

Lepidostrobus lepidophyllaceus? Gutb., Gæa. v. Sachsen. p. 89. Schp., Paleont. Veget., II. p. 65.

Sagenaria dichotoma (St.), strobile, Gein., Verst., p. 34, Pl. II, f. 6-8.

Strobiles large, cylindrical; axis small; sporanges short, broadly cuneiform, truncate at the top; blades open, large, lanceolate-acuminate.

Atl., f. 38, represents merely a sporange and bract, or a *Lepidophyllum.* Part of a cross section of a cone is figured in Geol. of Penn'a, l. c., but it could not be copied upon our plate for want of room. As the essential characters are taken from the blades, the omission is of no importance, the less so, as I have had occasion to study fragments in a better state of preservation. A specimen of Mr. Lacoe's collection is part of a cone, exactly cylindrical, nine and one half centimeters long, one and a half centimeters broad, without the blades, with an axis four millimeters in diameter. As seen from the separate *Lepidophyllum* (f. 38) upon the same specimen, which is one of the largest and best preserved I have had for examination, the sporanges are eight millimeters long, cuneiform, obtusely pointed at the base; the bracts three and a half centimeters long, seven to eight millimeters broad in the middle, equal at the base or rather narrowed than enlarged in joining the sporanges. As seen upon the cone and imbricated as they are at the base, the blades appear somewhat shorter and generally a little narrower, five to seven millimeters across.

The reference of this species by Geinitz to *Sagenaria dichotoma* is rightly contradicted by Schimper who has seen strobiles attached to the branches of this *Lepidodendron* with much narrower blades, and referable to *Lepidostrobus variabilis.*

Habitat—Mostly found in fragments, as *Lepidophyllum.* I first saw it at Carbondale in the collection of Mr. Chambers; then I found it at Mazon Creek, Ill., in nodules; in the shale of the Mammoth and five foot vein near Pottsville, Pa., and near Newport, R. I. The best specimen in the collection of Mr. R. D. Lacoe is No. 334*b*, labeled Hughsville deep shaft; others are from Brown's colliery E vein, and Griffith R. Road cut, Pittston, Pa.

LEPIDOSTROBUS OBLONGIFOLIUS, *Lesqx.*, *Pl. LXIX, Fig. 29.*

Geol. Rept. of Ill., IV, p. 441; Pl. XXX, f. 3, 3b. Schp., Paleont. Veget., III, p. 544.

Strobiles large with a broad axis; sporanges cuneiform acuminate to the base; blades oblong, lanceolate to the acute or slightly obtuse apex.

Differs from the former by the broader axis; the broader shorter blades mostly obtusely or abruptly acute, more distinctly hastate at the base; the longer sporanges acuminate to the point of insertion. Blades two and a half centimeters long, about one centimeter broad above the middle; sporanges seven millimeters long.

Habitat—Concretions of Mazon creek, rare. The cross section of another cone, shows the blades curved into the stone at the apex and thus apparently shorter and more obtuse.

LEPIDOSTROBUS OVATIFOLIUS, *Lesqx., Pl. LXIX, Fig. 32.*

Geol. Rept. of Ill., IV, p. 441, Pl. XXX, f. 2, 2b. Schp., Paleont. Veget., III, p. 544.

Strobiles cylindrical, of medium size; blades open, short, ovate lanceolate, blunt at the apex; sporanges short cuneiform.

The cone as figured in Geol. Rept. of Ill., l. c., a fragment seven centimeters long, averages two centimeters in diameter without the blades which are open, short, one to one and a half centimeters long, blunt at the top, largest at the base where they measure seven to eight millimeters in diameter. The sporanges are cuneiform and short, four millimeters long and equally broad at the point of attachment.

Habitat—Nodules of Mazon Creek. There is a fine specimen, No. 134, of the nodules in the museum of Princeton College. Two others, upon slate, referable to the same species, though less distinct, are in the cabinet of Mr. R. D. Lacoe, from Yatesville, Pa.

LEPIDOSTROBUS HASTATUS, *Lesqx., Pl. LXIX, Figs. 27, 28.*

Geol. Rept. of Ill., II, p. 456. Schp., Paleont. Veget., II, p. 65.

Lepidophyllum hastatum, Lesqx., Geol. of Penn'a, 1858, p. 876, Pl. XVII, f. 7.

Strobiles small, ovate; blades erect, short, enlarged at the base into diverging acuminate auricles, or hastate; sporanges long, oblanceolate or narrowly wedge-form.

The cone is like those represented by Ll. and Hutt., I, Pl. 10, f. *a*, and Pl. XI, left side, which the author refers to *L. variabilis.* As the characters of the bracts and sporanges are not indicated, I cannot tell whether this species is the same as that represented by the English specimens. The blades one and a half centimeters long, are distinctly hastate at the base. In my specimens of *L. variabilis*, the blades though about of the same size are not hastate but join the top of the sporanges by their whole width, the sporange being of the same length, while in this form they are evidently shorter only eight millimeters long. The shape of the strobile also should be considered in the comparison of the species to *L. variabilis.*

Habitat—The specimen described in Geol. of Penn'a, l. c., was given to me by Mr. W. D. Moore, now of Pittsburg, without indication of locality. One is described in the Geol. Rept. of Ill., from Mazon Creek. Mr. Lacoe has a number of specimens in his cabinet. One of them is figured here from the subconglomerate ledge of Pittston, Pa.

LEPIDOSTROBUS LACOEI, *Sp nov.*

Cone very long and narrow, cylindrical, flexuous, attached to a pedicel which, chaffy or scaly at its base, is higher covered with short narrow lanceolate imbricate leaves, and gradually increases in thickness to the base of the cone. Bracts short and broad, ovate, acuminate, narrowed in rounding to the point of attachment of the sporanges, closely imbricated; sporanges small, narrow and acuminate at the base, enlarged in joining the blades.

The species is a very remarkable one and is represented, beside some separate fragments, by a most beautiful and well preserved specimen. The base, which is like a fragment of *Rhizomopteris*, is a stem ridged in the middle, punctulate, five centimeters long, five millimeters broad, without the chaff composed of very small scales which cover it in a thickness of two and a half millimeters (stem with chaff ten millimeters broad). It supports a leafy stem, four centimeters long, five millimeters in diameter with the leaves, which are short, linear-lanceolate, acuminate, closely appressed and imbricated. This stem gradually increases in thickness upward to the base of the strobile which is forty-three centimeters long, two centimeters in diameter, including the blades which are closely imbricated appressed and incurved, showing mostly, on the outside, their backs carinate by a thick medial nerve. These blades are seven millimeters long, broadly ovate, acuminate, three to four millimeters broad in the middle, rounded in narrowing to the point of attachment to the sporanges. These are short, one and a half to two millimeters long, obovate, tumescent, attached by a comparatively broad base to a semi-globular mamilla, remaining prominent, as their scars, upon the axis. The line of connection between the bracts and the sporanges is no more than one millimeter broad.

This, and many other fine specimens seen after the preparation of the plates and too large for the limited space accorded to them, should be figured. The descriptions, however detailed they may be, cannot satisfactorily represent the plants.

Habitat—Oliphant, No. 1 vein; specimen No. 524 of the collection of Mr. R. D. Lacoe.

LEPIDOSTROBUS ORNATUS? *Ll. and Hutt.*

Foss. fl., I, Pl. XXVI; III, Pl. CLXIII. I. D. Hooker, Mem. Geol. surv. of England, II, 1847, p. 448, Pl. VII; VIII. Lesqx., Geol. of Penn'a, 1858, p. 876. Geol. Rept. of Ill., IV, p. 443. Schimp., Paleont. Veget., II, p. 67, Pl. LXII, f. 34–38.

Strobile narrow, variable in length; sporanges in right angle; blades short, broadly lanceolate, acuminate, closely imbricate and appressed, coriaceous, convex and carinate on the back by the thick medial nerve.

I refer to this species, with other fragments, a flattened cone, gradually narrowed from the base to the obtuse apex, fourteen centimeters long, two and a half centimeters broad at the base, fourteen millimeters at the obtuse slightly inflated top, with scales thick or coriaceous, closely imbricated, seven millimeters long, four millimeters broad at the base, inflated on the back, along the broad medial nerve. The cone is longer than those figured by the English authors. But one of the fragments in Hooker's, l. c., Pl. V, III, f. 1, indicates the length of the strobile as longer than in those which are represented whole, ibid., Pl. VII, f. 1, and in Ll. and Hutt., Pl. XXVI, f. 3. The scales also are slightly longer and narrower in our specimens. The other characters correspond. It is the only species seen in the American Coal measures with the blades rather scaly not foliaceous.

Habitat—Wilkesbarre, Clarkson's collection. Mazon Creek, in small fragments. The best specimens are from Cannelton, Pa., communicated by Mr. I. F. Mansfield.

LEPIDOSTROBUS ALDRICHI, *Sp. nov.*

Strobile small, cylindrical; blades very small, imbricated and appressed to the cone, lanceolate, acuminate enlarged at the base.

A small cone preserved in its whole, thirty-five millimeters long, ten millimeters in diameter. The blades or scales closely imbricated are apressed, four to five millimeters long, two and a half millimeters broad at the enlarged base, thick, coriaceous, with a thick prominent nerve.

Habitat—Subconglomerate coal of Alabama ; Montevallo mines, Mr. T. H. Aldrich.

There is upon a specimen of *Lepidodendron longifolium*, No. 559, in the cabinet of Mr. Lacoe, a cone two and a half centimeters long, one and a half broad, which has blades of the same size and form. It is covered with a coating of coaly matter, and the characters are not distinct enough to ascertain identity. The museum of Princeton has a fine specimen, No. 140, from the nodules of Mazon Creek. The cone is two centimeters long, one centimeter in diameter, cylindrical-oblong, obtuse at both ends ; the blades very thick.

LEPIDOSTROBUS CONNIVENS, *Lesqx.*

Geol. Rept. of Ill., IV, p. 442, Pl. XXXI, f. 6.
L. truncatus, Lesqx., ibid., p. 442, Pl. XXXI, f. 5.

Cones very small; blades long, narrow, linear-lanceolate, closely imbricate.

These two strobiles, described, l. c. under different names, are only two centimeters long and half as large, truncate at the base; one, *L. truncatus*, is oval, with shorter lanceolate closely imbricating bracts; the other, oblong-obtuse, has bracts apparently longer, covering the cone from the base to the top, where they join by an inward curve. Both fragments are somewhat obscure. They may represent two different species or merely the broken top of larger strobiles. They are distantly comparable to *L. gemmæformis*, Goep., Perm. fl., p. 142, Pl. XIX, f. 14–16.

Habitat—Concretions of Mazon creek.

LEPIDOSTROBUS SPECIES.

Geol. Rept. of Ill., IV, p. 440, Pl. XXX, f. 4–7.

Cone small, linear; blades erect, lanceolate; scars of their points of attachment broadly rhomboidal lengthwise, or broadly oval; sporanges in right angle with microspores exposed.

This is a mere longitudinal section of a cone in nodules. The blades are mostly destroyed, and the specific relation is uncertain. I figured it to show the horizontal position of the sporanges, which, by the section of the cone, are exposed, open, and the spores discovered. These are extremely small, three hundredth part of a millimeter in diameter, round on one side, triangular on the other. The sporanges are oblong, slightly emarginate at the point of union of the blades. It is the only strobile where I have been able to observe microspores.

Habitat—In a nodule of Mazon creek, split in the middle and exposing the inside structure.

LEPIDOSTROBUS INCERTUS, *Sp. nov., Pl. LXIX, Figs. 25, 25a.*

Strobiles cylindrical; axis narrow; sporanges very short, inclined and decurring to the axis; blades ovate, lanceolate-acuminate.

The fragment has not the appearance of a *Lepidostrobus*. The blades and sporanges seem continuous, the line of separation, f. 25*a*, being indistinct. The specimen is, however, somewhat obscure. It is a fragment of soft gray shale, where the blades are mostly immersed and their base generally indistinct. One specimen represents two bracts, somewhat more enlarged at the base than upon the figure; they are joined at the corner, and thus appear like a fragment of a sheath of *Lycopodites*. Other specimens may be found to elucidate the characters of this species.

Habitat—Morris, Ill. Shale above the coal.

Subgenus. LEPIDOSTROBUS (MACROCYSTIS), *Lesqx.*

Polysporia? Newb'y, Geol. Rept. of Ohio, Paleont., 1, p. 360.

Strobiles long; sporanges large, joined to the axis by their base, without any bracts; pedicels either none or shorter than the sporanges. Sporanges filted with macrospores attached around a central axis.

We have here, evidently, a distinct subdivision of *Lepidostrobus*. The species referable to it have been known, until now, merely from loose or scattered sporanges, whose reference to the genus was uncertain. To this subdivision is very probably referable the genus *Polysporia*, Newb'y, l. c. I should consider the reference as certain but for the remark of the author, that the sporanges are filled with microspores or very minute seeds.

LEPIDOSTROBUS (MACROCYSTIS), SALISBURYI, *Sp. nov., Pl. LXIX, Figs. 1, 2.*

Strobites cytindrical, very long, flexuous; axis broad, marked by long, narrowly ovat scars impressions of the base of large inflated linear oblong sporanges, without any pedicel or support.

This species is very rare. The fragments figured are part of long strobiles, sixty centimeters or more, flexuous, with sporanges in right angle to a broad axis to which they are attached by their whole rather enlarged than narrowed base. These sporanges inflated and bladder like, are of various size and shape, according to their relative position, their compression, etc., and when found separated from the axis have been referred to different species of *Carpolithes*. The axis is eight millimeters broad. The scars marked in spiral upon it as point of attachment of the sporanges, are four to five millimeters long, less than one millimeter broad in the middle. The sporanges one and a half centimeters in length and five to six millimeters in width are slightly emarginate, inflated in the middle, truncate at the point of attachment, and by cross section narrowly rhomboidal. The surface or thick epidermis is very thinly rugose across. The sporanges, f. 21–23, described as *Lepidocystis fraxiniformis* may be referable to this species.

Habitat—The fragment f. 1, is from Coal creek, W. Virginia. It was presented to me by Dr. Salisbury as part of a strobile more than four times as long, then in his possession. The specimen is S. 28 of the collection of the Museum of Comp. Zool. of Cambridge, Mass.

LEPIDOSTROBUS (MACROCYSTIS) QUADRATUS, *Sp. nov.*

Sporanges twice as broad as in the former species, square or equilateral, truncate at the point of attachment, emarginate at the outer end, sometimes bi or trilobate by compression.

Of this species I have numerous detached sporanges but only a small fragment of a cone, with two sporanges attached to the border of the axis, the only part seen. The average width of the spore cases is one and a half centimeters, their length three centimeters. I have always seen them flattened, merely slightly inflated per places, especially toward the outside borders, like bladders irregularly comcompressed. They however contain spores, as seen from some of my specimens where the macrospores pierce across the envelope at the inflated inside border like those of Atl., Pl. LXIX, f. 9, which however belongs to the following species.

Habitat—Cannelton, Pa. Not rare.

LEPIDOSTROBUS (MACROCYSTIS) MANSFIELDI, *Sp. nov.*

Strobiles large; sporanges oblong, truncate at both ends; spores attached around a medial or central broad axis.

The fragment, an upper part of a strobile is five centimeters broad and about eight long. The sporanges, in the lower part, are nearly in right angle to the axis, apparently empty or sterile, while in the upper part, they are filled with macrospores like f. 11, of Pl. LXIX, which is probably referable to this species. The sporanges however as seen attached to the stem are narrower, more distinctly truncate at both ends, two centimeters long, six to seven millimeters broad, with the sides parallel or rather narrower in the middle and slightly falcate. The axis is narrow only two millimeters in diameter and the sporanges appear as if they were disposed in two ranks and alternate. In these sporanges, when open and full of spores, the internal axis is not visible, the spores being heaped and crowded as in f. 11. Their disposition around the axis is surmisable from f. 10, an empty capsule also probably referable to this species, and copied from another specimen, a crushed strobile whose sporanges, in great number, are heaped and scattered, some filled with the spores as f. 11, some with the spore already detached, f. 10.

Habitat—Cannelton. Mr. I. F. Mansfield.

LEPIDOSTROBUS (MACROCYSTIS)? FOLIACEUS, *Lesqx., Pl. LXIX, Fig. 8.*

Lepidophyllum foliaceum, Lesqx., Geol. Rept. of Ill., IV, p. 444, Pl. XXXI, f. 10.

Sporanges rounded at the top, truncate at the base, obovate, flattened and undulate on the borders, attached to the axis by a thick pedicel.

Sporanges of this species have been formerly found in Illinois, but always separately, and I have been a long time before I could understand the relation of these peculiar organs. From the position of the three sporanges figured, and in comparison with the strobiles described above, they seem to belong to a strobile of analogous kind. The borders of the sporanges are always flattened and more or less deeply undulate on the surface and along the borders, undulations which vary according to the degree of compression, as seen in the three sporanges of f. 8. From the former species this one differs evidently by the narrowed base of the sporanges, attached to the axis by a pedicel and not by the whole base. The top of the sporanges appears like a rhomboidal flattened shield, imperfectly representing a blade and thus, the species partakes, as transitional form, of some of the typical generic characters and of those of the subgenus. The sporanges, two and a half centimeters long are six millimeters broad at the truncate base and twice as large near the apex. The axis is as yet unknown.

Habitat—Murphrysborough, Ill., main coal, the specimen decribed in Geol. Rept., l. c. Morris shale, Ill., specimen f. 8. It is check Ll. 36 of the Museum of Comp. Zool. of Cambridge, Mass. Seen also in nodules of Mazon Creek, Ill. I have from Cannelton a sporange referable to this species. It is shorter, narrower, with flat borders.

LEPIDOSTROBUS (MACROCYSTIS) MIRABILIS, (NEWBY.) *Lesqx.*

Polysporia mirabilis, Newby., Geol. Rept. of Ohio, Paleont., I, p. 362, Pl. XLI, f. 5, 5a, 6.

Cones consisting of a series of club-shaped sporanges thickly set upon a central axis and filled with minute spores.

The cone is seven to eight centimeters long, the sporanges of which there are perhaps a hundred on each cone are one and a half centimeters long, rounded at the remote extremity, narrowed and sometimes necked and wedged at the proximate end, filled with microspores, many hundred being contained in each. They are flattened and discoid as fossilized, but were originally spherical. They are often marked with radiating lines.

This description copied from the author would not leave any doubt on the identity of his genus with this section of the *Lepidostrobus* if the sporanges were not filled with microspores. Even f. *5a* of the plate, l. c., representing a separate sporange, is so much like f. 23 of Atl., Pl. LXIX, that both these organs seem specifically identical. The only difference (and it is a capital one) is that in all these specimens which I refer to *Lepidostrobus* (*macrocystis*) the spores are truly macrospores, easily distinct even their shape recognizable without a magnifier.

Habitat—Shale over a subconglomerate coal, Youngstown, O. Except this one, all the species described above are from the super-conglomerate coal measures.

LEPIDOPHYLLUM.

Blades or bracts either joined to sporanges or sporangiophores of Lepidostrobus or isolated.

The spore cases are rarely left attached to the pedicels or sporangiophores after their separation from the strobiles. A number of species described as *Lepidophyllum* represent fragments of linear leaves of *Lepidodendron*. These are very numerous, variable according to the mode of preservation, compression, etc. Their characters are unreliable. They are interesting and merit a description only when found in connection with the stems.

LEPIDOPHYLLUM AFFINE, *Lesqx., Pl. LXIX, Fig. 31.*

Geol. of Penn'a (1858), p. 875, Pl. XVII, f. 5.

Blade oblong, obtuse, not enlarged to the point of attachment; sporangiophores narrowed to the base.

The blade is two centimeters long, five millimeters broad, with borders exactly parallel from the base to the very obtuse half round apex. On the explanations of the plate the name is marked by error as *L. spatulatum.*

Habitat—A specimen from Yatesville, in Mr. Lacoe's collection at Pittston, No. 650, is the one from which our figure is copied. The specimen in Geol. of Penn'a, l. c., is from New Philadelphia, Schuylkill county, Pa. Species very rare.

LEPIDOPHYLLUM BREVIFOLIUM, *Lesqx., Pl. LXIX, Fig. 33.*

Geol. of Penn'a, (1858), p. 876, Pl. XVII, f. 6.

Blade very short, triangular, slightly obtuse at the apex; sporangiophores oblanceolate, narrow, longer than the blade.

The bracts are only six millimeters long, enlarging in a curve to the base, seven millimeters broad; the narrow sporangiophores are seven millimeters long, only two and a half millimeters at their point of union to the blades.

Habitat—I found this species abundant in a lower coal bed, at Wilkesbarre and Johnstown, Pa., always in scattered specimens separated from the cone.

LEPIDOPHYLLUM TUMIDUM, *Sp. nov.*

Blades and sporanges (united) oblong, narrowed and sharply acuminate at the apex, rounded to an obtuse point base of the sporanges; blades thick, inflated, especially in the middle, carinate by a thick midrib.

The sporanges nearly one centimeter long and as broad in joining the blade, are vertically rhomboidal, with the borders arched to the base; the line of attachment is obtusely angular in the middle, with the angle turned upwards. The blade, exactly of the same width as the top of the sporange, is continuous to it by its borders, the separation being marked only by the angular line closing the top of the sporanges. The bracts are one and a half centimeters long, thick, especially in the middle, tumescent along the medial strong nerve, rapidly rounded near the apex into a sharp and short acumen. By a cross section the convexity of the surface is marked as transversely oval, one and a half millimeters in diameter in the middle, flat on the borders.

Habitat—The specimen described is from Wilkesbarre, No. 565, of Mr. R. D. Lacoe's cabinet. I have seen another in a collection of Mr. Ch. Mammeth, of Newport. It was obtained from the anthracite of Mount Hope, Rhode Island.

LEPIDOPHYLLUM MORRISIANUM, *Sp. nov., Pl. LXIX, Figs. 40, 41.*

Blades lanceolate-acuminate, rounded and narrowed at base; sporanges obovate, narrowed downward to the point of attachment, rounded and contracted in joining the blades.

A peculiar form. The blades vary in length from two and a half to four and a half centimeters long, and from eight to twelve millimeters broad in the ovate part, toward the base. From this point they are gradually narrowed upward into a sharp long acumen, or subulate and rounded downward to the sporange which, in the specimen f. 40, where it is preserved, is five millimeters broad at its top. In a reversed position and in a reduced size, it has the same form as the blade, its length being only one centimeter. The medial nerve is triple.

Habitat—I have seen only the two specimens figured. They are from the shale over the coal of Morris, Ill. Communicated by Mr. S. S. Strong.

LEPIDOPHYLLUM MAJUS, *Brgt.*

Prodr. p. 87. Gein., Verst., p. 37, Pl. II, f. 5. Lesqx., Geol. Rept. of Ill., II, p. 456. Schp., Paleont, veget., II, p. 72, Pl. LXI, f. 8.

Blade large, oblong, lanceolate-acuminate, triplenerved by plication of the midrib; sporangiophores obovate, obtusely pointed at the base.

The species is much like f. 34, of Pl. LXIX, differing by the blade not enlarged in the middle, not undulate, and by the longer sporangiophores. The blades are generally from seven to nine centimeters long, and thirteen to sixteen millimeters broad.

Habitat—Rare in the American coal measures; most of the specimens of this species come from the Western coal measures; Morris and Clinton. Some are preserved in the cabinet of Mr. S. S. Strong. A fine one was communicated by Dr. I. H. Britts.

LEPIDOPHYLLUM MANSFIELDI, *Sp. nov. Pl. LXIX, Fig. 34.*

Blades larger in the middle, lanceolate, acuminate, flexuous and undulate across the surface from the middle to the base; sporangiophores gradually enlarging from the base to the line of union to the bracts.

Differs from the former by the sporangiophores being longer and narrower, the blades more rapidly contracted to a sharp acumen, more deeply and distinctly triple-nerved, and by the peculiar folds undulating the lower part of the laminæ. Some of these blades are narrow, not much larger than leaves of stigmaria, but always identifiable by the undulations of the lamina.

Habitat—Common in the Cannelton coal, and not seen elsewhere. Numerous specimens obtained present the same characters.

LEPIDOPHYLLUM AURICULATUM, *Lesqx.*, *Pl. LXVIII, Fig. 5.*

Geol. Rept. of Ill., II, p. 457, Pl. XXXVI, f. 6.

Blades shorter than in the former species, enlarged in the middle, lanceolate, acuminate, expanding at the point of union to the sporanges into two small half round auricles; surface minutely striate under the epidermis; medial nerve simple, sporanges oblong, obtuse to the base, enlarging upwards.

I consider this species as distinct on account of the auricled base of the blades, the simple medial nerve and the more sharply acuminate apex. Under the epidermis the surface is minutely lined lengthwise.

Habitat—Shale of the coal of Morris, Ill., not rare; also found at St. John, Ill., with *Lepidoploios auriculatus.*

LEPIDOPHYLLUM ACUMINATUM, *Lesqx.*, *Pl. LXIX, Fig. 37.*

Geol. of Penn'a, (1858), p. 875, Pl. XVII, f. 2.

Blades about the same size and shape as in the former species, lanceolate, more sharply acuminate, a little enlarged above the line of union to the sporangiophores, which are longer and oblanceolate.

The fragment described in the Geol. of Penn'a, l. c., under this name, is only the upper half of a blade, and I had then no other specimen for completing the diagnosis. In Atl., f. 37, the base of the blade is somewhat enlarged, but not distinctly auricled. Except this difference the chacacters of this and the former species are the same, the medial nerve is also simple, and both forms may represent mere varieties. In f. 37, however, the surface does not show any trace of vertical lines, and the specimens are from different localities. *L. trinerve*, Ll. & Hutt., II, Pl. CLII, is like this species by the form of the blades, but it is triple-nerved, with the veins distant.

Habitat—The specimen of the Geol. of Penn'a, l. c., is from the lowest coal of Johnstown, Pa. That of Atl., f. 37, is from Grape creek, near Danville, Ill., No. 3 of Mr. Wm. Gurley's collection.

LEPIDOPHYLLUM OBTUSUM, *Lesqx.*

Geol. of Penn'a, (1858,) p. 875, Pl. XVII, f. 3.

Blades long, linear, abruptly rounded at the top to a short acumen; medial nerve broad; sporangiophores not seen.

I have seen of this species only a few fragments from which the above description is made. The blade is nine centimeters long, thirteen millimeters broad at the base, where it is broken, twelve millimeters near the apex, where it abruptly curves to a short point. From other fragments found at the same locality, I supposed the blades to have been about twice as long as the part figured. It is thus far different from any other form of this group.

Habitat—Lowest coal bed of Johnstown, Pa.

LEPIDOPHYLLUM ROSTELLATUM, *Lesqx., Pl. LXIX, Fig. 35.*

Geol. Rept. of Ill., IV, p. 443, Pl. XXXI, f. 8.

Blade apparently thick, distinctly triple nerved, rounded in narrowing at base to the sporangiophore, to which it is joined by a narrow neck; sporangiophore rhomboidal, elongated, narrowed to the base.

The blade three centimeters to the part where it is broken, there one and a half centimeters broad, is of a thick substance, rounded at the base to a narrow neck five millimeters broad, which joins it to the sporange or sporangiophore. This, enlarged at the upper part to more than one centimeter wide, rounded at the corners, is narrowed by inside curves to an acuminate base. The sporanges appear to be still attached to the pedicel, which is thick and covered with a coating of coaly matter.

Habitat—Concretions of Mazon creek. No other specimen has been seen.

LEPIDOPHYLLUM STRIATUM. *Lesqx. Pl. LXIX, Fig. 36.*

Geol. Rept. of Ill., IV, p. 443, Pl. XXXI, f. 9.

Blades long, lanceolate, acuminate, triple nerved, distinctly lineate or striate in the length; sporangiophores in right angle to the blades, oblanceolate.

The first specimen described in the Geol. Rept. of Ill. represents two erect blades attached to sporangiophores in right angle. The sporanges are half buried in the stone and somewhat indistinct, the part which can be seen representing them as oblanceolate from below the point of attachment, which is destroyed. On this specimen, the blades broken at the top are also lacerated along the borders; their nervation is not distinct, and therefore the characters could not be fully ascertained. The blade figured now, represents the same species, as seen from the striation of the surface, a character which I have not seen distinct in any other *Lepidophyllum*. The blades are a little enlarged in the middle, slightly narrowing and curved to the line of union to the sporanges, lanceolate, sharply acuminate to the apex, distinctly triplenerved, seven and a half centimeters long, twelve millimeters broad in the middle, there scarcely one millimeter larger than at the base.

Habitat—Concretions of Mazon creek, the specimen figured in Geol. Rept. of Ill. The one represented here is from the cabinet of Mr. R. D. Lacoe, No. 199, from Butler mine, E vein. The blade of this last specimen is somewhat longer, and I considered it at first as a distinct species. The striate lamina is, however, a peculiar character, which indicates the identity of these fragments.

LEPIDOPHYLLUM LINEARIFOLIUM, *Sp. nov., Pl. LXIX, Fig. 39.*

Blade long and narrow, linear, subulate, rounded and *contracted to the point of attachment to the linear sporangiophore subulate to the base; sporanges enlarged at the top, oblong, truncate at the base.*

The specimen figured represents a blade with the sporangiophore only. I have had later for examination other specimens with the sporanges. The blades, carinate by a thick medial nerve, vary from seven to twelve centimeters long; their widest diameter towards the base is three millimeters, and from the base they are gradually narrowed, awl shaped to the apex. The sporangiophores one and a half centimeters long, are equally linear and inversely subulate. The sporanges are large, nearly one centimeter broad in the upper part, under the base of the blade, and one and a half to two centimeters long. As the sporanges are not open, the spores cannot be seen; but from the nearly smooth surface of the epidermis covering them, they appear to be microspores.

Lepidostrobus Bailyanus, Schp., Paleont. Veget., II, p. 71, Pl. LXI, f. 9, 9*a*, 9*b*, as represented by *Lepidophyllum* blades and open sporanges, is much like this species. The blades are about of equal size and length, but they are enlarged at the base and as broad as the top of the sporangiophores, while in our species they curve at the base, narrowing to half their width in joining the pedicels. Contrarywise, the sporanges are abruptly enlarged at the top, where they are twice as large as those of *L. Bailyanus*, oblong, truncate at the base, and filled apparently with microspores. The blades are carinate by a broad triple nerve, which is simple under the epidermis. Schimper's species is from the old Red Sandstone of Ireland.

Habitat—The specimen figured here is from Wilkesbarre lower coal bed, found there with *Lepidophyllum brevifolium*. It is Ll. 13 of the Museum of Comp. Zool. of Cambridge. The two other specimens with sporanges are in the cabinet of Mr. R. D. Lacoe, No. 85*c*, 85*a*, from Boston mine, C vein, Pittston, with a number of others probably referable to a different species, the blades, although of the same shape, being very short, two centimeters, with broad square sporanges, half as long as those of this species. I have specimens of the same character from Cannelton.

LEPIDOCYSTIS—*Lesqx.*

Spore cases long, naked, attached in right angle and opposite to a broad rachis, or short, placed in spiral order upon long flexuous axes, or isolated sporanges, detached from strobiles of unknown character.

The limitation of this genus is vague and uncertain. I refer to it as seen by the figures Atl., Pl. LXIX, f. 3–7, 16–24, organs which, though representing fructifications of the *Lycopodiaceæ*, are either obscurely related by their characters, or without affinity to what is known until now of the plants of this family. Under the same name are described sporanges detached from their support and of uncertain relation.

LEPIDOCYSTIS PECTINATUS, *Sp. nov., Pl. LXIX, Fig. 3.*

Axis flat and broad, supporting cylindrical contiguous aud parallel sporanges, pointed at both ends.

The figure does not need explanation. The fragment is distinct and exactly figured. The cylindrical capsules placed aside and contiguous, are evidently spore cases. They are broken or opened in some places by obliteration of the cortex. The inside is concave, corresponding in shape to the convex outside. They are all of the same size, one and a half centimeters long, about half a centimeter in diameter.

Habitat—The specimen is No. 423 of Mr. R. D. Lacoe's collection from the subconglomerate Campbell's ledge near Pittston. I have not seen any other.

LEPIDOCYSTIS LINEATUS, *Sp. nov. Pl. LXIX, Fig. 4.*

Sporanges short, parallel, nearly contiguous on the sides, attached by a truncate base to a flattened axis, regularly striate crosswise, marked in the middle by a prom-

inent ridge or nerve passing out at the top into a short blunt mucro.

The mode of attachment of the sporanges is not distinctly seen. They appear joined to a flattened axis by their base. As in the former species, the axis is striate. The sporanges are only half as long, seven millimeters, five to six millimeters broad, highly convex or rhomboidal by cross section, the upper angle being carinate by an inflation or nerve enlarging from the base to the outside, where it passes beyond the lamina into a short blunt point.

Habitat—The fragment is in the collection of Mr. Wm. Lorenz, of Philadelphia; found at South Salem vein of Port Carbon, Penn'a.

LEPIDOCYSTIS QUADRANGULARIS, *Sp. nov.*, *Pl. LXIX*, *Fig. 5.*

Axis broad, bearing elongated rhomboidal scars of sporanges; sporanges exactly cubic, joined to the axis by one of their faces.

The axis is three to four millimeters broad; the fragment represented in the figure being part of a long strobile whose shape was originally cylindrical, but which flattened by compression has lost by maceration the sporanges of its upper convex surface. These sporanges are short, three millimeters on each side; the point of attachment, as seen from the scars, is made by superposition of one of its faces.

Habitat—Collection of Mr. Wm. Lorenz, of Philadelphia. It is from the Mammoth vein.

LEPIDOCYSTIS OBTUSUS, *Sp. nov.*, *Pl. LXIX*, *Figs. 6, 7.*

Brachyphyllum obtusum, Lesqx., Geol. of Penn'a, (1858,) p. 876, Pl. XVII, f. 8.

Strobile long, flexuous, cylindrical and narrow; sporanges disposed in spiral, rhomboidal, obtuse or truncate at both ends; scars upon the axis same as in the former species.

The form is common in the lowest beds of the Anthracite, the Five Foot and Mammoth veins, there found always in fragments, some of them as long as twenty to thirty centimeters. The sporanges are somewhat larger than in *L. quadrangularis*, but possibly the enlarging and deformation is caused by vertical compression, for all the specimens seen are flattened. One of the specimens of Mr. Lorenz bears remains of this species on one side, while on the other it has others like those of the former. In comparing f. 6 and 7 of our plate with f. 8 of the Geol. of Penn'a, l. c., the outlines of these sporanges seem different. Indeed, it is extremely difficult to positively represent the shape of these sporanges, so varied it is even upon a same specimen. They are certainly sporanges. I have seen spores aside of a fragment of strobile; but have not been able to observe them in the interior of one of the spore-cases, which are of hard coriaceous texture. Probably some of these sporanges opened and bearing seeds will be found hereafter.

In Geol. of Penn'a (1858) this plant was erroneously referred to the genus *Brachyphyllum* established by Brongniart, Tabl. d. genres, p. 69, for branches of conifers of the Jurassic. I remarked, however, in the description, l. c., that this vegetable could not represent a true *Brachyphyllum*, but rather a narrow catkin of a *Lepidodendron* or a *Lepidostrobus*.

Habitat—Anthracite basin of Penn'a; not rare, but not seen elsewhere.

LEPIDOCYSTIS ANGULARIS, *Sp. nov.*, *Pl. LXIX, Figs. 16, 17.*

Strobile short, nearly round; spore case imbricated in circular rows, upon a broad axis; scales covering them ovate, angular at the top.

The analysis of these fragments is difficult, as I cannot positively see if the whole organism represents a cone or a mere sporange with spores covered with scales; f. 15 represents either the axis or the case emptied of its spores. I have now under my eyes another specimen of the same or of an analogous species which is twice as broad as f. 17, twenty-three millimeters transversely, and fifteen in vertical direction. The spores and their decking scales are also two ranked, but they appear disposed star-like in groups of five oval sori around a central elevated point like those of the Ferns. It is, however, evident that these vegetable organs cannot be referred to Ferns. The one not figured and larger is reniform or slightly emarginate in the middle, at both the upper and lower ends like a broad sporange with two valves opened, containing one-celled large macrospores.

Habitat—Communicated by Mr. R. D. Lacoe. Specimen Nos. 301 and 306, from Campbell's Ledge, sub or intra-conglomerate. The larger specimen not figured, is from Mr. I. F. Mansfield, No. 425, in shale of the Cannelton coal.

LEPIDOCYSTIS VESICULARIS, *Lesqx., Pl. LXIX, Figs. 18–20.*

Carpolithes vesicularis, Geol. Rept. of Ill., IV, p. 462, Pl. XXXI, f. 19–21.

Bladder-like sporanges, originally inflated, but flattened in the shale and deformed by compression.

These sporanges, averaging about one centimeter in diameter, are most varied in their forms, more generally irregularly oval, or nearly square in outline, or circular, inflated on the borders, with a round depression in the middle. F. 20 is probably a sporange of *Lepidostrobus* (*Macrocystis*) *quadratus*, as remarked in the description of this species.

Habitat—Not rare in the lower coal measures. Shale over the coal of Morris and Murphysborough, Ill. Abundant at Cannelton, Penn'a and around Pittston, as seen in the collections of Mr. I. F. Mansfield and Mr. R. D. Lacoe. Some of these sporanges show the spores under the erased epidermis.

LEPIDOCYSTIS FRAXINIFORMIS, (*Goepp.*), *Lesqx., Pl. LXIX, Figs. 21–23.*

Carpolithes fraxiniformis? Goepp. & Berg., De fruct. & Sem., p. 26, Pl III, f. 33, 34. Lesqx. Geol. of Penn'a, (1858), p. 877.

C.? Siliqua, Daws. Dev. Pl. of Maine, Quat. Journ. Geol. Soc., 1863, p. 465, Pl. XVII, f. 4.

Sporanges inflated or bladder-like, oblong in outline, rounded or truncate at both ends.

The sporanges containing spores, as seen, f. 21, are, like the former, very variable in size, from one and a half to nearly five centimeters long, and six to ten millimeters in diameter. Their shape is generally oblong, with both extremities obtuse or truncate. That they are true sporanges is seen by the scattered spores piercing through the epidermis, f. 21.

The reference of these sporanges to *Carpolithes fraxiniformis*, Goepp. & Berg., l. c., is far from certain, though the species of the European authors represent evidently spore cases with a medial pedicel, thus distantly comparable to *Lepidophyllum truncatum*, Atl., Pl. LXIX, f. 9.

Habitat—Abounds in a bed of subconglomerate shale below Pottsville, Penn'a, with remains of *Lepidodendron*. Also found by Mr. Lacoe, under the conglomerate near Pittston. I have received one specimen from Cannelton, Penn'a, by Mr. I. F. Mansfield. It is described by Prof. Dawson, from Perry county, Maine.

LEPIDOCYSTIS BULLATUS, *Lesqx., Pl. LXIX, Figs. 24, 24a.*

Carpolithes bullatus, Lesqx., Geol. Rept. of Ill., IV, p. 463, Pl. XXXI, f. 22–24.

Sporanges? small, half globular, irregularly wrinkled and flattened by compression.

Except that these bodies are much smaller than those described as *L. vesicularis*, they have the same characters. By inference and on account of this relation, I suppose them to represent sporanges. Perhaps the following species explains their nature.

Habitat—Common at the base of the coal measures above the Millstone grit, Ill. and Penn'a.

SPOROCYSTIS, *Lesqx.*

Agglomerations of macrospores, grouped together or cohering or agglutinate by the borders, more generally without cases, and therefore of uncertain reference. Pl. LXIX, f, 13, 14.

SPOROCYSTIS PLANUS, *Sp. nov., Pl. LXIX, f. 15, 15a.*

Spores flat, surrounded by a large border, variable in *form and size, connected to each others by the angular borders, like a mosaic work.*

These groups of spores are round or oval, the spores being apparently glued together by the borders or by a kind of indusium, and therefore of various forms, irregularly square or polygonal, smooth and inflated on the surface, marked with very small central mamillæ. They represent an agglomeration of spores like those found at the base of the *Selagineæ.*

Habitat—Abundant under the conglomerate at Pittston; communicated by Mr. R. D. Lacoe.

GENERA AND SPECIES DOUBTFULLY REFERABLE TO LYCOPODIACEÆ.

PSILOPHYTON, *Daws.*

Stems dichotomous; young branches carinate; rhizomes cylindrical, villous or scaly, marked with round scars points of attachment of cylindrical rootlets; leaves disposed in spiral, small or rudimentary, acicular, squarrose, open. Fructifications in small naked sporanges, spindle shaped or clavate, axillary or in pairs at the extremity of the branches.

On the plants of this genus, Schimper remarks, Paleont. Veget., III., p. 548: Notwithstanding the numerous details given by Prof. Dawson on the internal structure of these plants, their place among the vascular cryptogamous plants is not yet fixed. The circinnate vernation and the vascular scalariform tissue recall that of the Ferns; the general facies and the leaves relate the plants to some *Lycopodiaceæ*, while the disposition and the form of the organs of fructifications have not any analogy, in the fossil or even in the living cryptogams. It is, it seems, a lost type.

PSILOPHYTON PRINCEPS, *Daws.*

Geol. Sur. of Canada, 1871, p. 37, Pl. IX–XI.
Schp. Paleont. veget., III, p. 548.

Stem erect, repeatedly dichotomous; leaves in spiral, short, squarrose, slightly turned upward or in right an-

gle; fertile branches open, many times forked at the apex; sporanges numerous, generally geminate, pending; leaves of the fertile branches very short, scarcely discernible.

The stem of this species is comparatively large, measuring more than one centimeter in diameter. The fructifications, as figured by the author, are remarkably like those of *Archæopteris.*

Habitat—The author, in Devonian Plants of Maine, Q. J. Geol. Soc., 1863, remarks that this species has been found to extend from the very bottom of the Devonian series to the upper members, in Canada and through every part of eastern America, where land plants have been found These plants belong to the oldest representatives of the land vegetation. One species is described from the Silurian Cincinnati group, in Proc. Amer. Phil. Soc. v. XVII, No. 100, p. 163.

LEPTOPHLŒUM RHOMBICUM, *Daws., Nov. Gen. & Sp.*

Pl. of the Dev. Period of N. E. America, Quat. Jour. Geol. Soc., Nov. 1862, p. 316, Pl. XII. f. 8, and Pl. XVII, f. 53.

Stem covered with contiguous rhombic areoles, each with a single small scar a little above its center, and above this a very slight furrow. Decorticated stems with spiral punctiform scars in slight depressions. Bark thin, pith-cylinder very large, with transverse markings of the character of Sternbergia.

This plant seems to have presented a straight cylindrical stem, supporting leaves with thick bases, and of which only traces remain. Its bark was thin; and it seems to have had a thin woody cylinder, within which was a very large Sternbergia-pith. One specimen shows a growth of young wood at the extremity of the stem on which the rhombic scars are only imperfectly developed; and at the extremity of this younger portion the transverse structure of the pith exhibits itself through the thin bark in such a manner that this portion, if separated from the remainder of the stem, might be described as a *Sternbergia.* This is another peculiar phase of these remarkable, transversely wrinkled piths that seems to have belonged to so many of the carboniferous and Devonian plants. The markings on the surface of the stems of this plant somewhat resemble those of *Lepidodendron tetragonum*, *Ulodendron minus* and *Lomatophloyos crassicaule*, but the vascular scars and the general structure of the stem are different. I believe this plant to be more allied to *Ulodendreæ* and *Lepidodendreæ*, than to any other plants.

The above is entirely copied from Prof. Dawson's memoir, as this genus is, like the former, unknown to me, except from the description and figures of its author.

Habitat—Devonian measures of Maine.

TÆNIOPHYLLEÆ.

TÆNIOPHYLLUM, *Lesqx.*

Proc. Am. Phil. Soc. (1878), p. 330.

Stems large, leaves crowded, fistular, flat by compression, thick, exactly linear, decurring at the base, surface smooth, opaque or shining.

The plants referred to this division resemble those of the narrow-leaved *Cordaites* by the size of their leaves only. These are still narrower, more exactly linear, and their surface is not striate or marked by nerves, neither when corticated nor when deprived of their coaly epidermis. Seen with a strong glass, the epidermis appears lined lengthwise and crosswise by a very thin areolation composed of appressed square meshes resembling those of the finest tissue. The leaves, as far as they can be seen, are very long. I have not been able to find one in its entire length in any of the specimens examined. Their points of attachment still more than their smooth surface separates them from *Cordaites*, these points being marked by linear narrow scars, rounded and slightly inflated at the lower end, generally acute or acuminate upwards. The species referred to this group represent evidently a different generic division, if not a separate family.

The above description, taken from the Proc., l. c., is exact as far as the characters of the generic division could be recognized from the specimens bearing leaves only, which

I had then for examination. But recently Mr. I. F. Mansfield, to whom the American coal flora owes already the discovery of specimens of some of its most interesting types, has sent me a large piece of slate seventy centimeters long, covered with remains of *T. decurrens*, which forcibly eliminates the supposed relation of these plants to the *Cordaites*.

The specimen represents a trunk of *Stemmatopteris Schimperi*, covered with a coating of rootlets. To its borders are superposed, in close appressed confused masses, bundles of leaves of *T. decurrens*, diverging from it under an acute angle of 20–30°, exactly like those in Atl. Pl. LXXXI, f. 1, right side. These leaves are remarkably similar to the radicles covering the stems of *Stemmatopteris*, a little broader, however, apparently tubulose, or hollow cylinders flattened by compression, with a parietal tissue nearly half a millimeter thick. The hollow or inside canal of these leaves, as seen at divers parts where the parietal surface is open, is filled with closely appressed macrospores about one millimeter in diameter (flattened), distributed here and there in patches of various length. Some are seen continuous, five to six centimeters long, four to five millimeters broad, evidently enclosed into these hollow, fistular, leaf-like sporangiophores. As these groups of spores are distributed upon the whole surface of the specimen, and seen at divers places where the cortical tissue is destroyed, there can be no doubt about their relation to the leaves and their mode of attachment to them. But the connection of these bundles of filaments to the trunk of *Stemmatopteris* is not clear. Towards the lower part the decurring leaves cover the border of the trunk as if they were appressed upon it, and, therefore, possibly coming in contact by casual superposition. But towards the upper part, where the radicles covering the bark of *Stemmatopteris* are transformed into a thick layer of coal, this layer passes a little out of the borders of the trunks upon the base of the leaves of *Tæniophyllum*, as if these were derived from the same stem, though none of them are placed in the same direction as the radicles, and none appear mixed with them. There are evidently two kinds of vegetables. The question is only on the connection of the plants, either as casual by the deposits of a tuft of leaves of *Tæniophyllum*, upon the *Stemmatopteris*, or in a community of vegetation by parasitic association of this *Tæniophyllum.* The upper part of the trunk of this *Stemmatopteris* is free, without connection with any leaves of *Tæniophyllum.* On the first description of this plant, which was communicated to European Phytopaleontologists, Schimper, Grand d'Eury, and other authors have remarked upon the doubtful reference of these vegetable remains to *Cordaites.* No suggestion has been made upon their relation to any other group of the Carboniferous plants. The character of the fructifications refer them to the *Licopodiaceæ.*

The affinity to living species of this family is, however, not distinctly marked. They may be compared to some *Selaginellæ; Isœtes*, for example. In this genus the spores are axillary, placed in membranaceous sporocarps at the base of the leaves. The sporocarps ascend higher in the leaves than the spores, sometimes to half their length. In these carboniferous plants, the membranaceous spore-cases seem to have been distributed high up into the leaves, or in their whole length, bearing spores either continuous or in successive groups.

The axis of the *Isoeteæ* is short. What I have described as the stems of *Tæniophyllum*, as seen upon the specimen figured, may represent a prolongation of an axis of the same kind, a stump like that of Pl. LXXXIV.

The three species described under this generic name are closely related by the characters of their leaves. *T. contextum* seems a mere variety of *T. decurens* and *T. deflexum*, with its large flat ribbon-like leaves, may perhaps represent the sterile plants of the same species. The reticulation of the thin epidermis is in all of the same character.

TÆNIOPHYLLUM DECURRENS, *Lesqx., Pl. LXXX, Fig. 4; LXXXI, Fig. 1.*

*Lesqx., Proc. Am. Phil. Soc. (1878), p. 331, Pl. LI, f. 4; LII, f. 1.**

Characters of the species, same as for the genus.

Both the figures represent the leaves decurring upon the stem by an elongated base, but in Pl. LXXX the leaves preserve in their length as far at least as it can be seen the same diameter all along their decurring base, while in Pl. LXXXI they are gradually narrowed downward to their points of attachment, forming, as appressed upon another or against each other, narrow basilar prominent ridges. The leaves also of Pl. LXXX are slightly broader and more distinctly enlarged upwards. As the trunk of this specimen is not seen, I could not compare the point of attachment; and the characters of texture, facies and size of the leaves being the same, I consider them as variable forms of the same species. Perhaps even the variation is caused by a difference in the compression and maceration of fragments of a same plant. The crowded leaves average five to seven millimeters in width, forming by their imbricating and decurring long base a thick coating of coaly bark, which, when destroyed, leaves the surface of the stem smooth, or irregularly lined and wrinkled. It is marked by numerous leaf scars, some of them distinctly seen, others destroyed or obscure, so that their relative position is not definitely recognizable. The scars are placed in spiral order, but their place is not always indicated by the points of attachment. They are generally obtuse and inflated at the base, where they measure one millimeter in diameter only, gradually effaced and narrowed upwards, and therefore their characters are far different from those left by the leaves of *Cordaites*. The bark of the stem also is much thicker, not merely a thin smooth pellicle of coal, but a coating of shaly carbonaceous matter one millimeter thick or more.

Habitat—Cannelton, Penn'a; Mr. I. F. Mansfield.

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* The quoted Nos. of the plates of this genus and of the *Cordaites* refer to a few sets distributed before the definitive disposition of the plates, one of which is bound in the vol. of the library of the Am. Phil. Society.

TÆNIOPHYLLUM CONTEXTUM, *Lesqx., Pl. LXXXII, Figs. 2, 2a.*

Lesqx., Proc. Am. Phil. Soc., l. c., p. 332, Pl. LIII, f. 2, 2a.

Leaves narrow, linear, two millimeters broad, apparently very long, obtuse, twisted or interlaced together in tufts and erect, diverging and curved in the upper part.

This species merely differs from the former by the narrower leaves, more distinctly linear, compactly twined in the lower part. They are less flattened, evidently fistulose. Their substance is thick, the epidermis is a coaly layer irregularly disrupted in minute elongated granules, as in f. 2*a*. I have not seen any of these leaves in connection with a stem.

By compression and flattening, an inflated border is here and there formed along some of the leaves, and by their superposition the upper ones seem to have a midrib. In a few cases when the heavy coating of coaly matter is removed the thread-like vessels of the surface appear spread in loose fasciles similar to those of the leaves of *Dicranophyllum.*

Habitat—With the former.

TÆNIOPHYLLUM DEFLEXUM, *Lesqx., Pl. LXXXIII, Fig. 4.*

Lesqx., Proc. Am. Phil. Soc., l. c., p. 331, Pl. LIV, f. 4.

Stem or branch narrow; leaves closely imbricated, apparently decurrent, their base being covered by fragments of broken leaves decurring to and expanding in right angle from the stem; surface smooth.

The part of a branch figured here is entirely covered with broken fragments of detached leaves, and its surface is nowhere exposed; the leaves deflexed along the borders in right angle to the stem, seemingly from above the decurring base, are all flattened and parallel, their borders generally contiguous. They measure one centimeter in width and thirty-seven centimeters in length to the point where the specimen is broken. The coaly epidermis is, on the surface, very thin and fragmentary, or spread here and there like powder by decomposition; but the leaves taken altogether appear of a somewhat thick consistence. I have of this species only one specimen, a large piece of shale of which a fragment only is figured. Seen with a very strong glass, the veins of the surface may be approximately counted at twenty in one millimeter space; the cross wrinkles are also of the same size. The tissue of the epidermis is the same as in the former species, merely a little looser. The cross section of the leaves shows both surfaces separated by a thin layer of shale or clay, as if the leaves had been in their original state inflated or tubulose.

Habitat—With the former.

SIGILLARIÆ.

Trunks simple or forking near the apex, smooth, or longitudinally furrowed, marked by leaf scars of various forms, disposed in spiral order; leaves grass-like, triplicate, simple nerved; radicular appendages (*Stigmaria*) *thick, dichotomous, horizontally expanded, bearing long linear simple cylindrical fistulose or flattened leaves or rootlets, more or less regularly disposed in spiral order, leaving as their scars circular mamillæ, with a central vascular round point.*

The internal structure of the plants of this family is little known as yet, and there is still a degree of uncertainty in regard to their general characters, and to the relation which they indicate to plants of the present time. Brongniart, from the microscopical analysis of the structure of *Sigillaria elegans*, was disposed to consider the *Sigillariæ* as Gymnosperms, related to *Cycadeæ*. This opinion is admitted by Dawson and Grand'Eury; but the generality of authors refer this family to the *Lycopodiaceæ*. Binney, from a remarkably careful and precise examination of the internal structure of *Sigillaria*, Quat. Journ. Geol. Soc., May, 1862, Pl. IV, V; Phil. Trans., 1865, p. 580, Pl. XXXI–XXXV, exposes the result of his researches in the following conclusion (p. 591): "Everything led me to believe that the leaves, branches, and probably the fructifications of *Sigil-*

laria will prove to be very analogous to those of *Lepidodendron.*" Goldenberg, in Fl. Sarræp., liv. 1 and 2, refers *Sigillaria*, with *Stigmaria*, etc., to the *Selagineæ.* He represents, in Pl. A, the characters of the living plants of this family, and in Pl. B, comparative figures of those of the fossil *Selagineæ*, including the fructifications of *Sigillaria* in strobiles, in close affinity to those of *Lepidodendron*, only differing by the blades enlarged at the base, without sporanges, but vertically covering agglomerations of macrospores, much like those of Atl., Pl. LXVIII, f 6. It is evident that fructifications of this kind cannot be referred to Gymnospermous plants. From these considerations Heer, Weiss, Schimper, and Stur. admit the *Sigillariæ* into the family of the *Lycopodiaceæ* as a separate group, however.

As American specimens are not in such a state of fossilization that their internal structure can be studied, I consider the question merely from the outside characters of the plants, especially from the scars of their leaves as left upon the bark. In the divisions of the smooth (not furrowed) stems, the scars of some species of *Sigillaria* are of the Lepidodendroid type, for example, *Sigillaria monostigma* and *S. fissa*, Pl. LXXIII, f. 3–6; 17. Not only have these scars a single central vascular scar, without any traces of lateral bundles, but as seen f. 6, the subcortical impressions bear caudate appendages like the base of *Knorria* leaves, or similar to those observed in the subcortical state of *Lepidodendron Veltheimianum*, etc. The leaves also of *Sigillaria*, though generally longer than those of *Lepidodendron*, are of the same character, and cannot be compared to leaves of *Cycadeæ*, or of any other kind of gymnosperms.

As for *Stigmaria* as roots, the question of its true relation to *Sigillaria* or *Lepidodendron* is discussed with the description of the Genus.

SIGILLARIA, *Brgt.*

Trunks large, simple or dichotomous near the apex, marked by leaf scars in vertical series, separated by fur-

rows, or placed in spiral order, either contiguous or more or less distant, very variable in size and shape, round, oval, truncate or emarginate, hexagonal, transversely rhomboidal, etc., with three vascular scars, one simple medial punctiform, the two others lateral, of semi-lunar or linear shape. Leaves linear, long, triplicate, carinate or plane, with a distinct medial nerve.

The leaves are rarely found attached to the stems. Goldenberg, in his monography of the genus *Sigillaria*, disposes the species in four different groups, according to the general disposition and shape of the leaf scars: *Leiodermariæ*, *Clathrariæ*, *Rhytidolepis*, and *Syringodendron*. These subdivisions are followed and defined here for the description of the American species.

§ 1. LEIODERMARIÆ.

Surface of the trunks not costate; leaf scars more or less distant, not contiguous.

SIGILLARIA MONOSTIGMA, *Lesqx., Pl. LXXIII, Figs. 3–6.*

Geol. Rept. of Ill., II, p. 449, Pl. XLII, f. 1–5; IV, p. 446, Pl. XXVI, f. 5.

Schp. Paleont. Veget., II, p. 101.

Asolanus Camptotænia, Wood, Proc. Acad. Nat. Sci. Phila., p. 238, Pl. IV, f. 1.

Supercortical leaf scars broadly rhomboidal, constricted and acute at the sides, rounded at the upper and lower part; vascular scars simple, punctiform, in the middle of a smaller central rhomboidal mammilla, or naked, at or near the top of the leaf scars; decorticated surface very variable; impressions of the leaf scars generally large, oval, with a small transversely rhomboidal cicatrice and a vascular point in the middle, or with the cicatrices obsolete, topped by an enlarged vascular mamilla with an inflated linear protuberance like the inflated base of the leaves of a Knorria; surface between the scars always more or less distinctly and regularly striate in opposite directions, obliquely to the scars.

The cortex of this species is easily separated in thin lamellæ, and the scars vary in their characters according to the degree of decomposition or decortication of the trunks. I have endeavored to represent the more important of their features, but I must say that among two or three scores of specimens which have been and are still under my examination, I have rarely found two of them exactly similar in all their characters. The leaf scars especially are very variable. Generally the striæ of the surface, diverging from the scars in oblique and in opposite direction, are seen upon the successive layers of the bark, even some traces of them are left upon the decorticated surface of f. 6.

The subcorticated scars are much longer, oval, with the outlines of f. 4, without any rhomboidal scar, merely smooth, flat, or marked by a vascular point near the top. Upon the naked stem they are as nearly linear as in the lower part of f. 5.

The distance between the leaf scars vary from eight to twenty millimeters in the spiral direction of the scars, and from center to center. The average size of these scars in their state of preservation or as rhomboidal, is vertically five millimeters, one millimeter more transversely. In the decorticated state the oval scars measure eight to twelve millimeters vertically, and are only half as broad.

Schimper compares this species to *S. rimosa*, Gold., which it resembles indeed, as remarked in my first description, by the decorticated oval scars; but all the essential characters are different. *S. rimosa* has the triple vascular scars of a *Sigillaria*, while *S. monostigma* has only a single vascular point, and is by this character a transitional form relating this group of *Sigillaria* to *Lepidodendron*. In the European species also the striæ or wrinkles are lengthwise as seen upon all the specimens represented by Goldenberg, while in *S. monostigma* they diverge in opposite directions from the scars, and this also is seen upon all the corticated or semi-corticated American specimens which I have examined.

I know of no relation to this species which, until now, represents a type peculiar to the American coal flora. With the following it could be separated as a subdivision of the genus.

Habitat—Not rare at Colchester, Ill. Abounds at Cannelton, Penn'a, where Mr. I. F. Mansfield has obtained splendid and very numerous specimens representing the characters of the species in a multiplicity of forms. Found also at Pittston, coal B, by Mr. R. D. Lacoe.

SIGILLARIA FISSA, *Lesqx. Pl. LXXIII, Fig. 17.*

Geol. of Penn'a, (1858), p. 871, Pl. XIII, f. 4. Schp., Paleont. veget., II, p. 100.

Leaf scars distant, umbonate, rhomboidal, deeply emarginate at the upper border, rounded at the lower, angular on the sides; vascular scars marked by a single point near the top of an inside smaller rhomboidal mamilla.

This species is represented by a single specimen. It differs from the former by the scars a little more distant, deeply emarginate at the upper border, less enlarged on the sides, with a central convex mamilla, and by the wrinkles or striæ of the surface merely undulating lengthwise. Perhaps these characters are not persistent, and therefore should not be considered as specific. They are not remarked, however, upon any of the numerous specimens of the former species.

S. denudata, Goepp., Perm. fl., p. 200, Pl. XXXIV, f. 1, is closely allied to this species, differing essentially by the triple vascular scars.

Habitat—Muddy creek, near Shamokin, a locality where I found some plants of peculiar types not seen elsewhere, *S. Schimperi*, among others.

SIGILLARIA OBLIQUA, *Brgt. Pl. LXXIII, Fig. 18.*

Brgt., Hist. d. veget. foss., p. 429, Pl. CLVII, f. 1, 2. Lesqx., Geol. of Penn'a, 1858, p. 871.

S. rhomboidea, Brgt., ibid., p. 425, Pl. CLVII, f. 4. Gold., Flor. Sarræp., II, p. 22, Pl. VI, f. 6. Schp. Paleont. veget., II, p. 99.

S. Sculpta, Lesqx., Geol. of Penn'a, 1858, p. 871, Pl. XIII, f. 3.

Leaf-scars oblique, mammillate, rhomboidal, prolonged and rounded in the lower part, truncate or emarginate at the top, angular on the sides; vascular scars three, the *lateral ones long, linear, arched; cortex rugose, ribbed lengthwise.*

The leaf-scars are a little more than one centimeter distant from center to center in the oblique direction of the spiral, six to seven millimeters long and as broad between the lateral angles, rounded at the lower border and distinctly emarginate at the apex, (in the American specimens). *S. obliqua*, as figured by Brongniart and Goldenberg, has the scars obtuse, both at the upper and lower borders. It is on account of this difference that I did separate the American form as *S. sculpta*. Possibly, however, the disks upon the specimens seen by the European authors may have been somewhat deformed by maceration and compression. For in Brgt. f. 1, l. c., a few of them are slightly emarginate. Hence the essential characters being identical it is advisable to consider the American form as a mere variety. The subcorticated scars have not been seen by European authors. In the form described as *S. sculpta* the vascular scars seen under the cortex are double, oval, close, but not contiguous, four to five millimeters long, one to one and a half millimeters broad, twice as long, of the same width and in the same relative position as in Atl. Pl. LXXIII, f. 19*a*. The surface between them is irregularly and less distinctly wrinkled lengthwise.

Habitat—The species is not rare, and indeed presents different forms at the different localities where it has been found. As *S. sculpta*, I found it at the Gate vein of New Philadelphia, an upper coal. A specimen of the same type in the cabinet of Mr. R. D. Lacoe, No. 574, from the Plymouth colliery, represents it upon a surface of about fifty centimeters (square). I have seen it also from Duquoin coal, Ill. As *S. rhomboidea*, it is in many specimens from Oliphant, in the cabinet of Mr. R. D. Lacoe.

SIGILLARIA SPINULOSA, *Germ.*

Verst., p. 58, Pl. XXV. Gold., Flor. Sarræp., II, p. 20, Pl. X, f. 5. Schp., Paleont. veget., II, p. 102, Pl. LXVII, f. 12.

Cortex undulately striate lengthwise, slightly rugose crosswise; scars in quincunxial order, vertically and *longitudinally equidistant, trapezoidal, rounded at the lower border, narrowed to a truncate or slightly emarginate top; laterally angular in the middle; vascular scars three, the middle transversely linear or punctiform, the lateral linear, obliquely diverging; tubercles scattered in the intervals, small, centrally deeply concave.*

The only difference to note in the characters of the species, as indicated by the specimens I have for examination, is the smaller size of the disks. They measure seven to eight millimeters transversely and five millimeters vertically, while in the European form they average about two millimeters more in both directions. The distance from center to center in horizontal and vertical lines is two centimeters. The small tubercles scattered upon the bark in the intervals between the disks are rare, nearly immersed in the wrinkles, one and a half millimeters in diameter, apparently scars of adventive rootlets, as supposed by Schimper, rather than remains of the base of spines, as supposed by Germar. The wrinkles of the surface are not as large as in the former species and not smooth, but rugose crosswise; the leaf scars are narrower at the top, more broadly rounded at the base. I can see no other difference between this species and the former.

Habitat—This form is extremely rare in the American coal measures; I found the specimen described above, in a bed of sandstone shale, at Massillon, Ohio, and I have not seen any other. It is Si. 22*b* of the collection of the Museum of Comp. Zool., Cambridge, Mass.

SIGILLARIA DILATATA, *Lesqx.*

Geol. of Penn'a, 1858, p. 871, Pl. XIII, f. 5. Schp., Paleont. veget., II, p. 101.

Leaf-scars close and small; flat or slightly umbonate, enlarged and acuminate on the sides, the upper border emarginate, the lower arched; cortex minutely undulately striate lengthwise.

This species is quite distinct and easily recognized. The scars, six millimeters distant in their spiral direction, are vertically three millimeters in diameter only and twice as broad, being compressed and acuminate on the sides. The medial vascular scar is comparatively large, the lateral ones mostly joined and covering it. The decorticated surface is also rugose lengthwise, marked with thin undulating lines, and the vascular scars three, the two lateral oval, less than one millimeter long and half as broad, the medial one punctiform.

Habitat—Carbondale. First seen in the collection of Mr. Clarkson. Found later near Port Carbon and at Muddy Creek. Specimens Si. 17, 54, of the Museum of Comp. Zool., Cambridge.

SIGILLARIA RETICULATA, *Lesqx., Pl. LXXIII, Figs. 19, 19a.*

Geol. Rept. of Ark., II, p. 310, Pl. III, f. 2. Schp., Paleont. veget., II, p. 99.

Leaf-scars large, close, transversely rhomboidal, obcordate or emarginate at the upper border, enlarged and acuminate on the sides, rounded at the base; surface obscurely and irregularly costate lengthwise, transversely rugose.

The leaf-scars have about the same shape as in the former species, but are much larger, five millimeters high, eight millimeters broad, less dilated on the borders; the surface is distinctly transversely wrinkled, except around the somewhat umbonate scars, where it is smooth and also sometimes marked lengthwise by irregular large striæ, as in the specimen figured in the Ark. Geol. Rept., l. c. The decorticated surface has the vascular scars like those of the former species, comparatively larger.

Habitat—Male's coal bank, Ark. Sent also from the coal fields of Alabama, by Mr. T. H. Aldrich. As yet this species is subconglomerate.

SIGILLARIA LORENZII, *Sp. nov.*

Cortex distinctly undulately wrinkled lengthwise; leaf-scars in quicunxial order, vertically less distant than hori-

zontally, transversely oval, narrowed, but obtuse on the sides; vascular scars in the middle.

The species is closely allied to the former, differing by the form of the scars, oval, equally arched on the upper and lower border, contracted but somewhat obtuse on the sides, eight millimeters broad, and half as high. The decorticated scars are not exposed. The cortex is deeply undulately striate between the scars, which are one centimeter distant in horizontal direction, but slightly lineate in the space only half a centimeter wide, which separates them vertically.

Habitat—Seen in the cabinet of Mr. Wm. Lorenz, of Philadelphia, from Raush Gap, Mammoth vein, Penn'a.

SIGILLARIA STELLATA, *Lesqx., Pl. LXXIII, Fig. 20.*

Geol. of Penn'a, 1858, p. 871, Pl. XIV, f. 2. Schp., Paleont. veget., II, p. 101.

Leaf-scars in quincunxial position, plane, large, broadly rhomboidal-hexagonal, emarginate at the top, half round at the base, angular on the sides; cortex distinctly wrinkled in undulating striæ diverging star-like from the scars; vascular scars three, the lateral oval, the middle punctiform.

Species allied to *S. reticulata*, but widely different by the shape of the leaf-scars and the peculiar direction of the striæ of the surface. The scars, as broad as long, are eight millimeters in diameter, flat and smooth. The lateral vascular impressions are oval, as in the decorticated surface of the species of this group, with an arched line under them. The vertical distance between the scars is fifteen millimeters, the horizontal twenty-three.

Habitat—Seen in the cabinet of Mr. Clarkson, in splendid specimens obtained at Carbondale. The Museum of Comp. Zool., Cambridge, has one (Si. 2) from the same locality.

SIGILLARIA SCHIMPERI, *Lesqx., Pl. LXXIII, Fig. 21.*

Geol. of Penn'a, 1858, p. 871, Pl. XIV, f. 1. Schp., Paleont. veget., II, p. 101.

Surface transversely and vertically rugulose, horizon-

tally thinly striate; leaf-scars large, nearly round in outline; upper marginal line deep, extending horizontally on the sides; the lower less distinct; vascular scars two, oval, obliquely diverging, with an arched linear impression above them.

The figure is not exactly copied, in this only, that it does not well represent the rugosity of the surface thinly transversely striate by disconnected narrow lines traversing even the leaf-scars, and then rugulose obliquely between the scars which appear thus as placed into lozenge-shaped latticed frames. The leaf-scars, one and a half centimeters broad, one centimeter in vertical direction, are formed of an upper border marked by a deep broad highly convex line curved horizontally on the sides, with lower concave borders closing the circle under and near the vascular impressions.

The characters of this species are somewhat abnormal, especially in the absence of a medial vascular point, which is not remarked upon the specimen. The epidermis of the leaf-scars has been, however, partly destroyed, the scars being flat, not mammillate as they are generally in the species of this group.

Habitat—Found in the shale of an old mine of Muddy creek. The specimen is large, S. 1, Museum of Comp. Zool., Cambridge.

SIGILLARIA CORRUGATA, *Lesqx.*

Geol. Rept. of Ill., IV, p. 445, Pl. XXIV, f. 4; XXV, f. 5, decorticated.

Cortex deeply rugose lengthwise; leaf-scars large and distant, oval in outline, tumescent in the middle, with a round small mamilla and two oval lateral impressions under it.

This species has the facies of a *Lepidodendron.* The oval scars one centimeter long, seven millimeters broad, surrounded by a flat border one to two millimeters broad, are gibbous in the middle and there marked by a round vascular scar, placed between and above two lateral oval ones, which resemble the appendages of a *Lepidodendron.*

These scars are extremely variable, and when deformed by abrasion of one or two of the upper cortical layers, they generally preserve, as outlines of their essential characters, a large round vascular scar in the middle of an oblong impression, acuminate at both ends.

Habitat—Marseilles, Lasalle county, Ill. Specimens in a poor state of preservation.

SIGILLARIA LEIODERMA, *Brgt.*

Hist. d. veg. foss., p. 422, Pl. CLVII, f. 3. Schp., Paleont., veget., II, p. 98.

Cortex smooth, disks oval, not angular, marked in the center by a small horse-shoe-shaped or oval vascular scar.

I refer to this species two specimens with ovate leaf-scars or disks ten to fifteen centimeters long, four to seven millimeters broad in the middle, rounded at the lower border, obtuse and narrower at the top. One of them bears a single central oval scar or mamilla; the other is marked with a horse-shoe-shaped line under the vascular point. The disks are a little less obtuse at the top than in Brongniart's figure. The cortex in one of the specimens is very thinly lineate lengthwise; in the other it is slightly granulose.

The species of Brongniart is probably made from a specimen in a better state of preservation than those which I had for examination and which have the surface more or less obliterated. This may account for the difference in the characters.

The leaf-scars of this species, are much like those of the former. It, therefore, merely differs by the nearly smooth surface of the trunks. The reverse of one of the specimens, evidently decorticated, has large disks joined vertically by a tumescent prolongation of the base.

Habitat—One of the specimens with smaller disks is (Si. 24) in the collection of the Museum of Comp. Zool. of Cambridge, from Massillon, Ohio. The other is in the cabinet of Lafayette College, Easton, Pa., from Port Carbon, Pa.

SIGILLARIA LEPIDODENDRIFOLIA, *Brgt.*

Hist. d. veg. foss., p. 426, Pl. CLXI. Gold., Fl. Sarræp., II, p. 21, Pl. VI, f. 10, 11. Lesqx., Geol. of Penn'a, 1858, p. 871. Schp., Paleont. veget., II, p. 100.

Cortex irregularly striate, grooved lengthwise, but without ribs, transversely wrinkled under the areoles; leaf-scars rhomboidal-ovate, angular on the sides; upper and lower borders rounded; vascular scars three.

One of the specimens of this species, seen at Summit Lehigh in a private collection, represents it with the characters described by the author. The other has the leaf-scars irregularly disposed, as in Brongniart's figures, also of the same shape, but a little smaller. The scars deformed by compression are more generally oval, but those in a good state of preservation have the same form as in the European specimens, or like f. 3, Brgt., l. c., with smaller leaf-scars. These, though varying from seven to twelve millimeters long, have the same transversal diameter, seven millimeters.

Habitat—Specimen Si. 105, of the Museum of Comp. Zool. of Cambridge, is the one with smaller leaf scars, which I refer to this species. It is from the roof shale of Morris, Ill. The other specimen, from Summit Lehigh, was not obtainable. The species, very rare in the American coal measures, appears common in Europe, as besides the references quoted above, it is described also, without figures, by Heer and Grand'Eury.

§ 2. CLATHRARIÆ.

Scars contiguous by prominent borders forming a kind of lattice upon the cortex.

SIGILLARIA BRARDII, *Brgt., Pl. LXXIII, Figs. 8–16.*

Brgt., Hist. d. veg. foss., p. 430, Pl. CLVIII, f. 4. Gold., Fl. Sarræp., II, p. 25, Pl. VII, f. 7-10. Germ., Verst., p. 29, Pl. XI, f. 1, 2. Weiss, foss. fl., p. 161, Pl. XVI, f. 1; XVII, f. 7-9. Lesqx., Geol. of Penn'a, 1858, p. 872; Geol. Rept. of Ill., II, p. 451. Schp., Paleont. Veget., II, p. 102. Also described by Heer and Grand' Eury, without figures.

Scars transversely rhomboidal-oval, enlarged and acuminate on the sides; lower and upper borders round;

mamillæ of the same form, the upper border emarginate; vascular scars three, the lateral semi-lunar, the middle punctiform or transversely linear; surface epidermis lineate lengthwise; decorticated scars transversely oval, enlarged and acuminate on the sides, or totally obsolete, with two oval vascular scars; cicatrices of the rhizome small, circular, mammillate, with a large central vascular point; surface rugose by deep wrinkles diverging star-like from the scars; leaves narrow, broadly nerved, lineate.

Though very common in the middle coal measures, this species is rarely found in specimens affording points of comparison for its different characters which are of course variable, according to the state of preservation of the fragments. I have had opportunity of studying various forms, from a number of specimens obtained at the same locality where no other *Sigillaria* was discovered. As the modifications of the characters may be followed in comparing the divers fragments, I am satisfied that f. 8–16, of Pl. LXXIII, represents the same species. As seen f. 8 and 9, the leaf scars are variable in size; others not figured are still larger. The mamillæ, which are generally flat, are from four to seven millimeters broad, and the disks surrounding them proportionally large. Fig. 10 shows that sometimes the disks are not contiguous, the lower part being erased and the space vertically rugose. Fig. 12 is taken from the surface covered by a coaly epidermis, regularly vertically lineate, bearing, obscurely marked, the outlines of the disks underneath. F. 11 and 13 represent two states of decortication. In the first, f. 11, the disks are still distinct; in f. 13, they are totally erased, and the space between the vascular oval scars is vertically rugose. F. 14 is a fragment of the *Stigmaria* of this species, distinct by its small tubercles, and the deep wrinkles of the surface disposed star-like around the mamillæ. F. 15–16*a* represent parts of the leaves, enlarged. They are two millimeters broad, canaliculate by a thick medial flat nerve and very thinly lineate lengthwise, as is also the medial nerve incorrectly left smooth upon f. 16. Whole fragments of shale are covered with them. The base of the leaves, f. 15, is narrowed to the point of attachment and enlarged above. This figure is made from separate small pieces of shale which may represent folded leaves. The top of the fragment is lineate, as seen on the figure.

Habitat—The specimens described above are in the collection of Prof. J. P. Lesley, obtained in Washington county, by Prof. I. C. White. The species, not rare in the upper strata of the anthracite fields of Pennsylvania, is found also at Colchester and Duquoin, Ill., at Pomeroy and Coshocton, Ohio. It is rare in the lower coal strata, and has not been seen in the sub-conglomerate measures. Mr. Deudler, of Pittston, has a splendid specimen of this species, from Brown's colliery near the town.

SIGILLARIA MENARDI, *Brgt.*

Hist. d. veg. foss., p. 430, Pl. CLVIII, f. 5, 6. Lesqx., Geol. of Penn'a, 1858, p. 871. Schp., Paleont. Veget., II, p. 103.

Stems mammillate; areoles small, transversely rhomboidal-oval; scars nearlg as large as the mamilla, with borders parallel, the upper emarginate; vascular scars a single central point.

Except that the areoles and scars are less enlarged laterally, and the vascular scars simple and punctiform, there is no marked difference between this species and the former. Schimper doubts that they may be different. Indeed the casual erasure of the lateral vascular scars is often remarked even upon good specimens of *S. Brardii*, and in that case it is scarcely possible to decide to which of the two species the specimens are referable. The American specimens identified by Brongniart as *S. Menardi*, were sent to him by Cist, from Wilkes-Barre, where various forms of *S. Brardii* are commonly found. I have described this species (Geol. of Penn'a, l. c.,) from specimens bearing leaves, whose vascular scars are not discernible. I, therefore, believe that Schimper's supposition is right.

On the explanation of the plates, the name, *S. Menardi*, is, by error, given to f. 7, Pl. LXXIII, which represents *S. ichthyolepis*, *St.*

Habitat—The specimen mentioned above (Si. 15), Mus. Comp. Zool. Cambridge, is from Muddy creek; another (Si. 9*b*) is from Wilkes-Barre, and a third (Si. 84) from Pomroy, O.

SIGILLARIA SERLII, *Brgt.*

Hist. d. veg., foss., p. 433, Pl. CLVIII, f. 9. Gold., Flor. Sarræp., II, p. 25, Pl. VII, f. 5, 6. Lesqx., Geol. of Penn'a, 1858, p. 872.

Trunks marked with small elevated rhomboidal bolsters disposed in quincunxial order, contiguous; scars central, transversely rhomboidal; vascular scars three points, horizontally disposed in the middle of the scars.

Brongniart considered the place of this species as uncertain. Goldenberg refers it to a *Lepidophloios.* Schimper makes it a variety of *S. Defrancii.* From positive evidence, the species merely represents a small branch of *Ulodendron majus*, Ll. & Hutt. As I formerly described as *S. Menardi* a fragment of this *Ulodendron*, I was near making the same mistake in referring a small branch of the same to *S. Serlii*, the characters being perfectly concordant with those of Brongniart's species.

Habitat—This branch, mentioned above, is part of a splendid specimen of *U. majus*, No. 581, of the collection of Mr. R. D. Lacoe. It comes from Butler mine, E. vein, Pittston, and represents a number of varieties in the characters of the bolsters of this species.

§ 3. RHYTIDOLEPIS

Stems more or less distinctly costate; cicatrices discoid; vascular scars three.

A. Leaf-scars approximate, nearly contiguous at the base.

SIGILLARIA DOURNAISII, *Brgt.*

Hist. d. veg., foss., p. 441, Pl. CLIII, f. 5. Gold., Fl. Sarræp., II, p. 28, Pl. VII, f. 22-24. Schp., Paleont. Veget., II, p. 82. Heer, Fl. foss., Helv., IV, p. 41, Pl. XVI, f. 2.

Leaf-scars upraised or mammillate, hexagonal, upper and lower angles obtuse or truncate, the lateral acute

American specimens differ merely from the European form by the scars smaller, scarcely five millimeters in diameter, both ways, and vertically more distant, five millimeters. The species is closely allied to the following, but really distinct. The vertical distance between the leaf-scars is longer—four to five millimeters.

Habitat—Subconglomerate coal of Alabama, Woodworth seams, Helena; communicated by Mr. T. H. Aldrich.

SIGILLARIA TESSELLATA, *Brgt.—Pl. LXXII, Figs. 2–4.*

Brgt., Hist. d. Veg. foss., p. 436, Pl. CLVI, f. 1; CLXII, f. 1–4. Gold., Fl. Sarræp., II, p. 29, Pl. VII, f. 14–15. Schp., Paleont. Veget., II, p. 81, Pl. LXVIII, f. 1–3. Heer, Fl. foss. Helv., p. 41, Pl. XVI, f. 3–4.

Phytolithus tessellatus, Steinh., Trans. Amer. Phil. Soc., I, p. 295, Pl. VII, f. 2.

Sigillaria microstigma, Brgt., l. c., p. 478, Pl. CXLIX, f. 2, decorticated, (fide Schimper.)

S. elegans, Brgt., l. c., p. 438, Pl. CXLVI, f. 1. Gold., l. c., p. 27, Pl. VI, f. 16–17.

S. Knorrii, Brgt., l. c., p. 444, Pl. CLVI, f. 2, 3; CLXII, f. 6.

S. alveolaris, Brgt., l. c., p. 443, Pl. CLXII, f. 5.

Lepidodendron alveolare, St. Fl. d. Vorw., I, p. 23, Pl. IX, f. 1.

Sigillaria minima and ornata, Brgt., l. c., p. 434 and 435, Pl. CLVIII, f. 2, 7, 8.

S. dentata, Newb'y, Ann. of Sci., of Clevel., v. 1, p. 165, f. 4.

Favularia tessellata, Ll. & Hutt., Foss. fl , I, Pl. LXXIII–LXXV.

F. elegans, variolata; Aspidiaria variolata, St.; Palmacites variolatus, Schloth, etc.

Scars small, hexagonal or ovate, enlarged in the lower part, or broadly oval, obtuse or acute at the borders, contiguous; decorticated surface either narrowly irregularly striate, with leaf-scars marked by small round mamillæ and a central vascular point, or smooth, with obovate elongated and inflated bolsters deeply emarginate at the top, with an oval depression in the center, (as seen f. 4 a, 4 b.)

This species is so variable that the leaf scars of any specimen referable to it have rarely the same shape. Most of the forms referred to this species by Schimper's synonimy, quoted above, have hexagonal scars, truncate at both the upper and lower borders, angular at the sides. The American specimens have them mostly enlarged and rounded on the lower side and base, narrowed to the upper truncate emarginate border; of the same characters as represented in Brgt., l. c., Pl. 162, f. 2 and 4, or in *S. elegans*, Gold., l. c., Pl. VI, f. 17, 17*a*. The lateral angles are often obscured by compression, or covered by superposition of imbricated borders. Schimper refers still to this species, *S. ichthyolepis*, St., *S. hexagona*, Brgt., and *S. pachyderma*, Brgt., which are described and figured here as distinct.

The form described by Prof. Newberry as *S. dentata*, differs by the areoles marked at the base by a small distinct tooth. The author remarks that the species resembles in many respects *S. alveolaris* and *S. Knorrii*, Brgt., and that if these are to be considered identical, *S. dentata* should perhaps be regarded as a variety. In *S. tessellata*, as in *S. alveolaris*, the shape of the areoles is so variable that a specific distinction founded on this character is scarcely advisable. Still I have never observed the sharp basilar acumen of the leaf-scars in any of the forms referable to *S. tessellata*. *S. dentata* may, therefore, be a good species.

Habitat—Generally found in the whole thickness of the middle coal measures, especially in the anthracite fields of Wilkes-Barre, Pittston, etc. Also at Cannelton, Penn'a. Massillon, Ohio. Rare in the west. I have found it at Murphysborough, Ill.

SIGILLARIA ICHTHYOLEPIS, *St.*, *Pl. LXXIII, Fig. 7.*

Corda, Beitr., p. 29, Pl. IX, f. 19. St., Fl. d. Vorw., II, Pl. XXXVIII, f. 2b. Gold., Fl., Sarræp., II, p. 27, Pl. VII, f. 17.

S. tessellata, Schp., Paleont. Veget., II, p. 82.

S. Biercei, Newb'y, Ann. of Sci. of Clevel., v., 1 p. 164, f. 2.

Areoles upraised, flat on the surface, broadly hexagonal; furrows in zigzag, deep and carinate; vascular scars three, semi-lunar, the lateral diverging.

Our figure, copied from a well-preserved specimen, is exactly similar to the representations of this species by the European authors. By the deep furrows, the shape of the bolsters, even the shape and direction of the vascular scars, this form seems, indeed, far different from any of the varieties of *S. tessellata*.

Habitat—This species is very rare. It has been figured only by Sternberg and Corda, from the Carboniferous limestone of Radnitz, Bohemia, and in America by Prof. Newberry. The figure of the Atl. is copied from a piece of soft-grained sandstone, from Newport, Ind., sent by Mr. Gurley, of Danville, Ill. Prof. Newberry received his specimen from Mr. L. V. Bierce, of Akron.

SIGILLARIA HEXAGONA? *Brgt., Pl. LXXII, Fig. 1.*

Brgt., Prodr., p. 65; Hist. d. veg. foss., p. 439, Pl. CLV, CLVIII, f. 1. S. tessellata, Schp., Paleont. veget., II, p. 81.

Leaf scars hexagonal; vascular scars three, the middle punctiform, the lateral semi-lunar.

Brongniart species is considered by himself and most of the European authors as a variety of *S. tessellata.* The leaf-scars are upraised, transversely six millemeters, vertically only four. The size is, of course, variable, according to the age of the trunks; but in all the representations of this species, the same proportion is remarked in the size of the scars, always distinctly broader transversely than vertically. The American specimen, which I doubtfully refer to this species, has the six sides equal, five millimeters, and the scars are, therefore, as high as broad, nine millimeters in diameter. They are not elevated as bolsters, but flat and vertically separated by a linear scarcely undulate furrow, as in *S. mamillaris*, a species to which it might be referred as a variety rather than to *S. tessellata.*

Habitat—This specimen, like the former, is unique. It was sent for determination by Mr. Tyler McWorthen, from the coal measures of Illinois.

SIGILLARIA MAMILLARIS, *Brgt., Pl. LXXII, Figs. 5, 6.*

Brgt., Hist. d. veg. foss., p. 451, Pl. CXLIX, f. 1; CLXIII, f. 1. Gold., Fl. Sarræp., II, p. 32, Pl. VIII, f. 6–8. Schp., Paleont. veget., II, p. 83. Veiss, Foss. fl., p. 164, Pl. XV, f. 1–4.

Leaf-scars of various size and shape, pyriform or oblong-ovate, broadly obtuse at the lower border, truncate at the top, angular or rounded at the sides, separated by a straight linear furrow; vascular scars triple, the medial punctiform, the lateral semi-lunar; super cortical, vascular scars as in the former species; decorticated surface *striate, with scars represented each by a small round mamilla, with a central vascular point.*

The size of the scars is as variable as their outlines. They are generally larger in American specimens than represented by European authors, except by Weiss, who, l. c., has figured a specimen with cicatrices much like those in the lower part of Atl., f. 5. They vary from five to ten millimeters long, and from four to eight millimeters broad in the lower part, where they are generally enlarged.

F. 5 of Pl. LXXII, is very interesting on account of the deformation of the scars, as seen in the middle. This deformation is peculiar, not merely considering the shape and the displacement of the cicatrices, but from its periodical appearance. Large specimens are marked at equal distance by the same dimorphism of scars, as regularly as are the stems of *Calamites* by articulations. This is seen, for example, upon specimen No. 475*a*, of Mr. Lacoe's collection, where three distinct zones of deformed cicatrices appear at fifteen centimeters distance. This specimen, a part of a stem, is fifty centimeters long. The fluting of the surface is continuous in the whole length, and not at all deranged by the presence of these abnormal scars, though some of them are placed in the middle of the furrows, or covering them. They are oval tubercles, highly convex, slightly variable in size, narrowed and obtuse at both ends, oblique or vertical in direction. Their crest is cut by deep lines or notches, linear, slightly enlarged in the middle, smooth along the borders, rugose crosswise on the sides.

These deformed bolsters, remarked also upon specimens of *S. tessellata*, are considered by Schimper as points of insertion of strobiles of fructifications. The shape and convexity of these tubercles is against this supposition, as also the periodical reappearance of these organisms and their irregular directions upon the stems. They are like buds, which, stopped in their growth by unfavorable weather at the end of a season of vegetable activity, have been withered before development, and have been, later, pushed aside by other new buds, in the beginning of a new period of vegetation. This seems proved by the displacement of withered buds by the new ones developed into leaves, as seen by the cicatrices mixed with these tubercles. A phenomenon of this kind, seen upon branches of living conifers, indicates the annual renovation of the vegetation. The decorticated vascular scars of the deformed buds or tubercles are mere small points.

Habitat—Two specimens, with small scars, in the Museum of Comp. Zool. of Cambridge, are subconglomerate—one from the Ætna vein of Tennessee, the other procured by Prof. J. P. Lesley, in the subcarboniferous measures of Virginia. The beautiful specimens figured and described here from the cabinet of Mr. R. D. Lacoe, are from Oliphant, N. 1. vein,

B. *Leaf-scars more or less distant, angular on the sides, obtuse or acute at the base; ribs distinct.*

SIGILLARIA LESCURII, *Schp., Pl. LXXII, Figs. 7, 8.*

Schp., Paleont. Veget., II, p. 85.

S. attenuata, Lesqx., Cat. Pottsv. Sci. Assoc., 1858, p. 17, Pl. II, f. 1, 2., and by error in explanation of the plate.

Ribs equal and narrow, plano-convex; scars large, ovate, enlarged and angular near the base, obtuse or slightly emarginate at the upper border, more or less distant; surface of the stem rugose in the intervals; vascular scars placed in the upper part; decorticated surface striate, its scars simple, triangular, flat.

This species is much like the former. It differs by the cicatrices abruptly enlarged towards the base and the rugose surface which separates them. The ribs are narrower, at least comparatively, less than one centimeter broad between the scars, which, by their base, fill nearly the whole space between the very narrow deep furrows, generally marked by a deep line.

Habitat—Wilkes-Barre, Ashland Gap, and Trevorton, Anthracite basin of Penn'a. The specimens figured have been communicated by Mr. H. W. Poole, of Pottsville.

SIGILLARIA NOTATA, *Brgt.*

Hist. d. veg. foss., p. 449, Pl. CLIII, f. 1. Gold., Fl. Sarræp., p. 38, Pl. VIII, f. 1. Schp., Paleont. veget., II, p. 87.

Phytolithus notatus, Steinh., Trans. Amer. Phil. Soc., I p. 294, Pl. VII, f. 3.

Ribs narrow, convex, separated by a lineal narrow furrow; leaf-scars short, obtuse, and narrowed at the apex, acutely angular on the sides below the middle; vascular scars three.

The ribs of this species are a little larger than those of the former, and the leaf-scars much smaller, five millimeters vertically, four millimeters between the enlarged part below the middle, rounded or obtusely angular at the base. In the decorticated state which has not been described by European authors, the vascular scars are double oval tubercles, three millimeters long, one millimeter broad.

Habitat—The specimen which represents this species in both corticated and decorticated states, Si. 15, is in the collection of the Mus. Comp. Zool. of Cambridge, obtained from Port Carbon.

SIGILLARIA CUSPIDATA, *Brgt.*

Hist. d. veg. foss., p. 457, Pl. CLIII, f. 2. Gold., Fl., Sarræp., p. 38, Pl. VIII, f. 2. Schp., Paleont. veget., II, p. 87.

Bark thin; ribs plano-convex; scars longitudinally distant, small, ovate or oblong in outline, truncate at the top, gradually enlarged to below the middle, and rapidly cuneate to the acute base, which is thus triangular; vascular scars three, placed above the middle; bark rugose below the scars, punctulate above them, smooth on the borders; decorticated surface thinly striate, its vascular scars two, parallel, long, narrowly oval, accuminate at both ends.

The species, as described above from an American specimen, differs from the figures by which it is represented by European authors. The tumescent leaf-scars are much smaller, eight millimeters long, five millimeters broad between the angles above the base; the vascular scars are placed lower; the ribs also are larger, sixteen to eighteen millimeters, and the scars vertically less distant only fifteen millimeters. In Brongniart's figure, the leaf-scars twelve millimeters long, are twenty-six millimeters distant. Notwithstanding the difference in the measurement, the essential characters, as described by Brongniart, are identical. The epidermis or upper cortex is as thin as a leaf of writing paper, the shape of the slightly oblique cicatrices is exactly the same; the vascular scars, though placed a little lower than described by Brongniart, are of the same type; the middle very small, the lateral long, arched; the surface is rugose below the scars, the wrinkles obliquely turned upward and parallel to the base of the scars, gradually disappearing downward, the bark above the top of the scars being merely rugulose or punctulate. We have for only point of comparison the figure given by Brongniart. It has been copied by Goldenberg, and it does not appear that any other specimen has been seen, as the subcorticated scars are not described.

Habitat—The species is very rare. The only specimen known until now from the American coal measures is in the collections of Mr. R. D. Lacoe, No. 622, from Plymouth, Penn'a, old mine F. It has been figured for the Atlas, but like those of many other species, it has been left out from want of place.

SIGILLARIA MASSILIENSIS, *Lesqx.*

Geol. Rept. of Ill., IV, p. 446, Pl. XXV, f. 3-4.

Ribs flat; furrows deeply cut and carinate; surface striate lengthwise; leaf scars large, rhomboidal, obtuse at the top, enlarged to the middle, triangular at the base; vascular scars three, the lateral ones semi-lunar, the medial horizontally oval.

The cicatrices have about the same outline as in the former species. They are, however, larger, especially broader, and comparatively shorter; twelve millimeters long, eight millimeters broad between the lateral sharply acute angles, placed a little higher, or about in the middle. The characters of the decorticated surface are unknown, as no other specimen has been found except the fragment figured. The flat ribs are twelve to fourteen millimeters broad.

Habitat—Found in the sandstone of Marseilles, Ill.

SIGILLARIA ATTENUATA, *Lesqx., Pl. LXXII, Fig. 9.*

Lesqx., Cat. Potts. Sci. Assoc., 1858, p. 17, Pl. II, f. 3.
Schp., Paleont. veget., II, p. 85.
S. Leseurii, Schp., by error in explan. of the plate.

Ribs narrow, equal, plano-convex; furrows deep; leaf-scars ovate, hexagonal, rounded at the base, narrower and truncate at the top, angular below the middle, distant; vascular scars placed in the upper part; intervals transversely rugose.

The characters of this species are in a reduced size nearly identical to those of *S. Lescurii.* The ribs are only narrower, the scars much smaller, five to six millimeters long, three to four millimeters broad in the largest part below the middle, and two and an half centimeters distant. The three specimens, f. 7, 8, 9, were sent to me from the same place as probably derived from a same tree. I admit, however, the distinction made of these forms by Schimper.

Habitat—Ashland Gap, Pa., communicated by Mr. H. W. Poole.

SIGILLARIA WILLIAMSII, *Sp. nov.*

Ribs distinct, convex, depressed in the middle; scars very small, ovate in outline, slightly angular or enlarged on the sides and rounded to the base, truncate or slightly emarginate at the top; vascular scars three, the middle punctiform, the lateral semi-lunar, opposite; decorticated, vascular scars simple, small, round, mammillate.

The ribs a little more than one centimeter broad, separated by deep narrow furrows, are convex on the borders and there striate, flat or slightly concave in the middle, rugulose or punctulate between the scars which are at least four centimeters distant; leaf scars four to five millimeters long, slightly emarginate at the top, two millimeters broad, enlarged downwards to three millimeters, and abruptly curved or rounded to the base.

Species comparable to the former, differing by the leaf scars more distant, shorter, broader than long, not angular at the middle or curving lower to the base; by the broader ribs with rugose depressions in the middle, striate on the borders. In the decorticated state the vascular scars are simple round small mamillæ, and the surface is obliquely rugulose, not striate. It is also closely related to *S. Lacoei*, Atl. Pl. LXXII, f. 12. The leaf scars are about of the same character; the cortex is flattened or slightly convex in the middle; the difference is essentially in the width of the ribs and the distance of the scars.

Habitat—There is in the cabinet of Mr. R. D. Lacoe, No. 719, a large specimen obtained by and named from Mr. Sam'l P. Williams, an active contributor to that collection, with another specimen, No. 526, both obtained at Oliphant No. 1 vein.

SIGILLARIA LEPTODERMA, *Sp. nov,, Pl. LXXII, Fig. 10.*

Ribs of medium size, plano-convex, coarsely irregularly striate; leaf scars small, narrowed and emarginate at the apex, enlarged to near the basilar half round line; vascular scars nearly in the middle; cortex thin, obliquely rugose above the scars; decorticated surface distinctly lineate, with vascular scars large, double, lanceolate, obtusely pointed.

The ribs are one and an half centimeters broad, plano-convex, sometimes flattened in the middle, separated by equal parallel deep carinate furrows; the scars, nearly four centimeters distant, are five millimeters long, equally broad and angular in the widest part above the rounded basilar line; the vascular scars are small, three, the lateral ones linear and slightly curved, the middle punctiform. The upper cortex is very thin, obscurely and more or less irregularly striate, rugulose above the top of the scars, the oblique wrinkles forming a short conical latticed impression, gradually effaced upwards. The under surface is distinctly marked by continuous thin lines, and the decorticated vascular scars, comparatively large, are formed of two parallel lanceolate mamillæ, five to six millimeters long, two millimeters broad at the inflated rounded base.

The species is allied to the former, but essentially distinct, by the character of the subcortical vascular scars, a character, however, extremely variable. For in some specimens the subcortical scars are oblong, obtuse at both ends, still larger than those figured, nearly like those of the small forms of *S. lævigata* and *S. reniformis.*

Habitat—Represented in numerous and large specimens in the collection of Mr. R. D. Lacoe, from Plymouth, Pa., F vein.

SIGILLARIA PULCHRA, *Newby.*

Ann. of Sci. of Clevel., v. 1, p. 165, f. 3.

Trunk narrowly ribbed; ribs prominent, slightly rugose, alternately expanded and contracted; areoles lenticular, rounded above and below, with acute lateral angles: vascular impressions two, nearly round, separated by a rounded tubercle; decorticated surface longitudinally striate, bearing obscure impressions of the leaf-scars.

The ribs, eight millimeters broad in the enlarged space, are alternately contracted to five millimeters between the areoles. These, two centimeters distant, measure six millimeters transversely, four vertically.

The author remarks that this species resembles, in the alternance of width of the ribs, *S. contracta*, Brgt., and *S. diploderma*, Corda, but differs from both by the leaf-scars and the vascular impressions. As seen from the figures, the areoles are like those of *S. transversalis*, Brgt., and the characters of the ribs as in *S. diploderma.*

Habitat—Youngstown, Ohio, Sub-conglomerate coal measures.

C. Leaf scars obtuse at the top; borders laterally diverging in a curve, angularly bent at the arched basilar line.

SIGILLARIA POLITA, *Lesqx., Pl. LXXIII, Fig. 1.*

Lesqx., Geol. of Penn'a, 1858, p. 872, Pl. XIV, f. 3.

Ribs nearly flat, very smooth; furrows deep and narrow; scars discoid, rounded at the top, enlarged on the sides, joined in an obtuse angle to the slightly arched basi-

lar line; vascular scars near the apex, the lateral ones distant, semilunar, the medial straight or arched upward.

This species is closely related to the following, differing merely by narrow ribs and broader discs. These are one centimeter broad near the base and five to six millimeters in vertical direction. The subcorticated surface is not seen upon the only specimen which I had for examination. Schimper does not record this species in Paleont. Veget., probably considering it as identical with the following. Its relation is with *S. Saullii* and *S. hyppocrepis*, Brgt.

Habitat—Carbondale, Clarkson's collection.

SIGILLARIA YARDLEI, *Lesqx., Pl. LXXIII, Fig. 2.*

Lesqx., Cat. Pottsv. Sci. assoc., p. 17, Pl. II, f. 4. Schp., Paleont. Veget., II, p. 85.

Ribs plano-convex, smooth; leaf scars trapezoidal, obtuse at the top, half round at the enlarged base; vascular scars, near the upper border; subcortical surface distinctly striate, with leaf scars simple, oval, small, mammillate.

Though the ribs are broader, the scars are smaller and more distant than in the former species. Except this the characters are about the same.

Habitat—Presented by Mr. T. W. Yardley, as obtained near Pottsville. I have lately found some good specimens of the species at the Mammoth bed of Raush Gap, Pa.

SIGILLARIA ORBICULARIS, *Brgt.*

Hist. d. veg. foss., p. 465, Pl. CLII, f. 5. Gold., Fl. Sarræp., p. 42, Pl. VIII, f. 20, 21. Schp., Paleont. Veget., II, p. 87.

Ribs flat; scars nearly round, very obtuse or slightly emarginate at the top, larger below the middle; borders scarcely angular in rounding to the base.

The American specimens agree with very little difference to the descriptions and figures of the European authors. The ribs are flat, generally somewhat narrower, ten to eleven millimeters broad; the furrows straight and narrow; the leaf scars smaller than the ribs, broader than long, slightly narrowed to the obtuse top, rounded at the base. The vascular scars, three, have the general character, the medial one being a short transversal bar punctate in the middle. The decorticated surface has not been seen by the authors quoted above. It is indistinctly lineate or striate, and its vascular scars are represented by oval corrugated mamillæ or oval patches of coaly matter indicating the shape of the scars as simple and nearly round.

Habitat—Seen in good specimens in Mr. R. D. Lacoe collection (No. 616, 616*a*, 621) from Maltby, Pa., and also from Seneca mine, F vein, Pittston.

D. Leaf scars oval or ovate, not angular on the sides, truncate emarginate or obtuse at the top, rounded at the base.

SIGILLARIA VOLZII, *Brgt., Pl. LXXII, Fig. 11.*

Brgt., Hist. d. veg. foss., p. 461, Pl. CXLIV, f. 1. Schp., Paleont. veget., II, p. 88.

S. Sillimanni, Gold., Fl. Sarræp., II, p. 35.

Ribs narrow, plano-convex, equal, obliquely rugose above the scars; discs ovate; vascular scars nearly in the middle; decorticated surface thinly lineate lengthwise, its vascular scars simple, small, oval mamillæ.

In the American specimens the ribs and scars are a little larger than figured by Brongniart and the latteral borders of the discs are not at all angular, but gradually rounded to the base. The convex ribs, one centimeter broad, separated by deep narrow parallel and equal furrows, are obscurely rugose lengthwise, and distinctly marked above the scars by oblique wrinkles diverging upward. The scars are one centimeter long, six millimeters broad in the lower part, slightly emarginate at top. The cortex is somewhat thick, about half a millimeter.

In comparing the figure to that of *S. Sillimanni*, Pl. LXXI, f. 6, the great difference in the characters is easily remarked.

Habitat—Rare in the American coal measures. The specimen described, the only one I have seen, is No. 494, of Mr. R. D. Lacoe's collection, from Plymouth F vein.

SIGILLARIA PITTSTONIANA, *Sp. nov.*, *Pl. LXXI, Fig. 4.*

Ribs flat, convex on the borders only, along the deep large parallel equal furrows; surface irregularly minutely rugose; scars comparatively small, oval, obtusely truncate at the top; vascular scars in the middle of the cicatrices; bark very thick; decorticated surface still more obscurely striate, its scars small, oval.

The ribs always flat, except along the borders, vary in diameter from eight to fifteen millimeters. In the largest forms the scars are seven millimeters long, four millimeters broad, rounded at the base, truncate at the top, sometimes narrower and obtuse at both ends. The vascular scars, of the general character, are placed in the middle of the cicatrices. In the decorticated state they are simple, oval, obtuse at both ends, scarcely one millimeter broad in the middle, and four to five millimeters long.

The species is allied to *S. rugosa*, Brgt., l. c., p. 476, Pl. CXLIV, f. 2.

Habitat—The collection of Mr. R. D. Lacoe, of Pittston, has numerous specimens of this species from Plymouth F vein. The characters are persistent upon all.

SIGILLARIA SILLIMANNI, *Brgt.*, *Pl. LXXI, Fig. 6.*

Brgt., Hist. d. veg. foss., p. 459, Pl. CXLVII, f. 1. Gold., Fl. Sarræp., II., p. 35, Pl. IX, f. 4; X, f. 12. Lesqx., Geol. of Penn'a, 1858, p. 872. Schp., Paleont. veget., II, p. 88.

Ribs narrow, plano-convex, slightly undulate, punctate or rugulose above the scars; leaf-scars ovate, truncate at the top, enlarging towards the rounded base; vascular scars placed above the middle; decorticated surface distinctly lineate, its vascular scars double, oval, small, close to each others.

The ribs seven to nine millimeters broad, are distinctly convex; the scars two to three centimeters distant, eight millimeters long, five to six broad toward the base, are ovate, truncate, or slightly emarginate at the apex, gradually enlarged downwards to the half round base. Sometimes the scars are topped by a small round mamilla, as described and figured by Goldenberg, l. c.; but it is generally indistinct and even totally erased upon most of the specimens. The cortex is either smooth or punctate, rarely rugose, and the lateral vascular scars are generally united at the base in the form of a horse-shoe, an unimportant character, for they are sometimes cut and separate upon the same specimen, as seen, f. 6. In f. 4 of Gold., l. c., the cortex is thinly lineate, as in some of our specimens. In Brgt., l. c., f. 1, it is transeversely, coarsely rugose. This character is indicated for the typical form, while the ribs with the smooth or linear surface represent var. B, found at Saarbruck, and described by Goldenberg. The subcortical vascular scars are generally double, small, oval, as seen on the left side of f. 6 of our plate; sometimes they are united in one and nearly round—this, however, very rarely.

Habitat—The first specimens of this species were sent to Brongniart by Cist, with the locality indicated as mines of Wilkes-Barre. The species is common in that region, as it is represented in its varieties by numerous specimens in the cabinet of Mr. R. D. Lacoe, especially from Plymouth F vein.

SIGILLARIA ELLIPTICA, *Brgt.*

Hist. d. veg. foss., p. 447, Pl. CLII, f. 1-3, CLXIII, f. 4, Gold., Fl. Sarræp., II, p. 39, Pl. VII, f. 19-21, VIII, f. 3. Schp., Paleont. Veget., II, p. 84.

Ribs plano-convex, narrow, transversely rugose between the scars; cicatrices ovate, obscurely hexagonal, obtuse at the top and the base; vascular scars in the upper part of the cicatrices.

This species is allied to *S. Lescurii*, as represented Atl., Pl. LXXII, f. 8, differing by the obtuse apex of the cicatrices not enlarged in the lower part. The ribs average one centimeter in width; the scars are close, three to five millimeters distant, one centimeter long, five to seven millimeters broad, and the space between them is distinctly transversely rugose. The characters of the subcortical surface are not given by the authors. From our specimens this surface is obscurely very thinly lineate, the lines not perceivable with the naked eye, and the vascular scars are oval simple mamillæ, two and an half millimeters long, one millimeter broad.

Habitat—I refer to this species a large number of specimens obtained at the mines of Cuyahoga falls, Ohio (Si. 6), in the collection of the Mus. Comp. Zool., Cambridge. I have received one specimen from Cannelton, by Mr. I. F. Mansfield. There are also some in the cabinet of Mr. R. D. Lacoe, from Plymouth F vein.

SIGILLARIA OVALIS, *Sp. nov. Pl. LXXI, Figs. 7, 8.*

Ribs flat, equal and parallel; furrows marked by a mere line; surface smooth; cicatrices oval or ovate, a little narrower at the obtuse top than at the rounded base; vascular scars at or above the middle; decorticated surface distinctly, coarsely lineate, its scars simple, small, narrowly oval.

Differs from the former by the oval comparatively narrower areoles, by the greater distance between them and by the surface, which is smooth even between the scars. The bark is nearly one millimeter thick; the space between the cicatrices is about one centimeter, same as the length of the scars, whose width averages only five millimeters. F. 8 shows a remarkable plicature of the bark in thin layers alternately superposed upon each other.

Habitat—The specimens (No. 466) are in the cabinet of Mr. R. D. Lacoe, from Plymouth, F vein.

SIGILLARIA CORTEI, *Brgt.*

Hist. d. veg. foss., p. 467, Pl. CXLVII, f. 3, 4. Gold., Fl. Sarræp., II, p. 47, Pl. VIII, f. 12. Gein., Verst., p. 45, Pl. VI, f. 1–3; IX, f. 7. Schp., Paleont. veget., II, p. 87.

S. dubia, Lesqx., Geol. of Penn'a, 1858, p. 872.

Ribs narrow; scars distant, oblong-ovate, obtuse at both ends; corticated surface thinly striate.

Species closely allied to the former. The ribs plano-convex, generally narrower, average six to seven millimeters in width. The corticated surface is thinly striate or obscurely rugose; the cicatrices are narrower, a little strangled below the top, more distant; the furrows are deep and large, well defined. Geinitz, l. c., represents the species from a splendid specimen bearing leaves. The only American specimen which I refer to this species is that described in Geol. of Penn'a., l. c., as *S. dubia*. It differs merely by slightly larger ribs, not larger, however, than those of f. 2 of Gein., l. c.

Habitat—Lower coal bed of Trevorton, Penn'a.

S. OBOVATA, *Lesqx.*

Geol. of Penn'a, 1858, p. 872, Pl. XIV, f. 4.

Ribs broad, nearly flat, indistinctly lineate; furrows deep and narrow; scars comparatively small, exactly ovate; surface marked by a few round tubercles, without regular order of position.

This species, improperly named, differs especially from all those of the group by the large costæ, more than two centimeters broad. The ovate scars, seven millimeters long, six millimeters broad, in the lower part, are shorter and more enlarged to the rounded base than those of *S. ovalis*, its nearest relative. They are also more distant, ten millimeters at least. The subcorticated surface is very obscurely lineate, a little more distinctly than the cortex; its vascular scars are simple oval mamillæ, as in *S. ovalis*.

Habitat—Lower coal bed of Trevorton, with the former.

E. RIBS LARGE, GENERALLY DIVIDED IN THREE ZONES.

SIGILLARIA ACUMINATA, *Newby.*

Ann. of Sci. of Clevel., v. 1, p. 164, f. 1.

Trunk ribbed; ribs parallel, moderately elevated, divided into five bands, of which the central is most prominent, widest, rugose, and of unequal width; lateral stripes striated longitudinally; leaf scars pyriform, crowned by a *long claw-like appendage, which is sometimes bifid; vascular impressions low down in the leaf-scars; decorticated surface ribbed, marked by linear depressions.*

The ribs are fifteen millimeters wide, the scars two and a half centimeters distant, obtuse at both ends. The author remarks that in obscure specimens the acuminate appendage of the leaf-scars is hardly perceptible. Except this and the somewhat lower position of the vascular impressions, the characters of the species are the same as in *S. rugosa*, Brgt.

Habitat—Shale over the coal of Cuyahoga Falls, Ohio.

SIGILLARIA RUGOSA, *Brgt.*

Hist. d. veg. foss., p. 476, Pl. CXLIV, f. 2. Lesqx., Geol. of Penn'a, 1858, p. 873. Schp., Paleont. Veget., II, p. 92.

Costæ flat; furrows narrow, distinct, obtusely carinate, bordered with narrow, lateral, smooth zones; medial zone punctulate or rugulose between the scars; scars discoid, oval, distant; vascular scars three, in the upper part of the disks, the middle punctiform, the lateral oblong parallel.

This description is translated from Brongniart, who made it from American specimens. From the figure, l. c., the ribs, including the flat narrow zones which border them, are eighteen millimeters broad, with a deep, narrow furrow. The scars, ovate, obtuse at both ends, gradually widening from the top to below the middle, are eight millimeters long, six millimeters broad in the widest part, filling the medial punctate flattened zone of the ribs, which is slightly contracted between the scars nearly two centimeters distant. The decorticated surface is striate, its vascular scars simple, narrowly oval, five millimeters long.

On this species Brongniart remarks that with two others which he describes, *S. Deutschiana* and *S. canaliculata*, it has the costæ divided in three longitudinal zones, the medial one, containing the leaf-scars and the lateral ones, separated by a less distinct furrow, offering generally a notable difference in the aspect of the surface, etc. Species with this character are rightly separated in a peculiar section of the genus.

Goldenberg, fl. Sarræp., II, p. 48, Pl. VIII, f. 26, describes and figures as a variety of *S. rugosa*, a form which, from what is said above by the author, should be considered different, the ribs being very narrow, eight millimeters, without flattened borders; the scars only eight millimeters distant, very small, five millimeters long, four millimeters broad, and the subcorticated vascular scar a round mammilla. The only character I find in concordance between the two forms is the rugosity of the surface between the scars. The relation of *S. rugosa* with *S. Pittstoniana* is remarked in the description of this species.

Habitat—The variety, according to Schimper, is common in Saarbruck. The form described by Brongniart is from a specimen sent to him from Wilkes-Barre, by Cist. I have as yet seen nothing referrable to it from the American coal measures.

SIGILLARIA MARGINATA, *Sp. nov., Pl. LXXI, f. 5.*

Costæ very large, bordered by a broad striate zone; medial furrows distinct, but narrow; scars large, distant, truncate at the top, enlarged to the middle, rounded to the base; surface between the scars more or less punctate; decorticated surface lineate, its scars double, oval, long, contiguous in the middle.

The ribs, two and a half centimeters broad, are bordered on each side by striate distinct zones, as broad as the medial space occupied by the scars, and separated by very narrow furrows; the middle costa, six to seven millimeters broad, is obliquely rugose above and below the scars, punctate in the intervals. The cicatrices, eight millimeters long, six millimeters broad below the middle, have the vascular scars in the middle, the central punctiform or marked by two short parallel lines, the lateral ones long, vertical, parallel and linear. The decorticated surface has the characters described above.

As seen from the figure, the decorticated part looks like an upper cortex. But the specimen is an overturned impression. The middle zone of the ribs is somewhat convex.

The line traced above the figure represents a cross section of the surface.

This species is distantly related to the former, and also to *S. canaliculata*, Brgt., mentioned above as referable to this group.

Habitat—The species is represented by specimen reverse of No. 460, in the collection of Mr. R. D. Lacoe. It is from Plymouth, Penn'a, F vein.

SIGILLARIA LACOEI, *Sp. nov., Pl. LXXII, Figs. 12–12b.*

S. discoidea ? Lesqx., Geol. of Penn'a, 1858, p. 873, Pl. XIV, f. 5.

Ribs large, convex, canaliculate in the medial zone; leaf-scars small, often deformed, narrowed at both ends and obtuse, or, when in a good state of preservation, oval or ovate, emarginate at the top, scarcely enlarged to the rounded base; vascular scars in the upper part of the disks.

This species, represented by a large number of specimens, may be considered of the same group as the former, the ribs being composed of a medial zone, flat or concave, with two very large distinctly convex borders. The bark is thick, two to three millimeters, according to the width of the ribs which measure one and an half to five and an half centimeters across. The outside zones are highly convex, the medial one concave, narrow, four to six millimeters broad, with scars distant, three to four centimeters, often deformed by lateral compression of the outside zones, very small, seven to ten millimeters long, three to four millimeters broad, oval, acute at both ends when deformed as in f. 12, emarginate at the top and round at the base, in the normal state of preservation, f. 12*a*, enlarged twice underneath. The decorticated surface is convex without trace of the medial concave zone, distinctly and regularly lineate. Its leaf scars are generally represented by one, sometimes by two, mamillæ, originally five to six millimeters long, rounded and broader at one end, tapering to a point, f. 12*b*, same specimen as f. 12*a*. I say originally, for the subcortical scars in this species greatly vary, increasing in size under the cortex, while the surface scars preserve the same size and outlines. Thus, specimens with leaf-scars like f. 12*a*, have subcortical narrowly oval scars one and an half centimeter long, either simple or double, separated or contiguous on the sides. Old stems have them two centimeters long, eight to ten millimeters broad, oblong, cordate at base, slightly emarginate at the top, showing thus the lateral connection of two mamillæ. Others still are large and ovate, nearly round, tuberculate, like the discs of *S. discoidea*, Lesqx. l. c., a form which may merely represent a variety of this or of one of the following species which have the subcortical scars subject to a metamorphism of the same kind.

Habitat—Pittston. Seen in numerous specimens in the collection of Mr. R. D. Lacoe, from Plymouth vein F.

SIGILLARIA LÆVIGATA, *Brgt. Pl. LXXI, Figs. 1–3.*

Brgt., Hist. d. veg. foss., p. 471, Pl. CXLIII. Gold., Fl. Sarræp., II, p. 51, Pl. VIII, f. 32. Lesqx., Geol. of Penn'a, 1858, p. 873. Schp., Paleont veget., II, p. 93.

Costæ very large, smooth; furrows deep, carinate; cicatrices small, hexagonal, truncate or emarginate at top, enlarged to the rounded or angular base; subcortical surface distinctly striate; its scars oval, elongated, contiguous, separated in the middle by a round or oval areole.

The scars of the cortex are rarely preserved, at least upon American specimens. They are described by Brongniart and Schimper as regularly hexagonal, while all those I have been able to examine have the lower part more generally rounded than angular. These scars are very small, at least in proportion to the great width of the ribs, which measure five to six centimeters in diameter or more, while the leaf-scars are only five millimeters long and as broad near the base. As seen f. 1–3, the subcortical scars are variously deformed. F. 3 has the tubercles oval, contiguous, at least at the top and the base, with a depression in the middle. In f. 1 and 2, they are united in one, flattened, large, two to three centimeters long, one to one and an half broad, sometimes even much larger, diversely cut, even in their central part as those in the upper part of f. 2. The subcortical scars indicate that their growth has been progressing under the bark, and that the deformation is caused by various degrees of compression, according to the space which they had for their development. This expansion is not easily explained; for the bark, more than one millimeter thick, is not split as seen f. 1, which has the subcortical cicatrices already of far greater size and development than those of the cortex. The bark is, however, rarely preserved upon the same specimens bearing enlarged subcortical deformed bolsters.

Habitat—Not rare, but generally found in a decorticated state. Splendid and very instructive specimens are in the cabinet of Mr. R. D. Lacoe, from Plymouth vein F, and others around Pittston.

SIGILLARIA RENIFORMIS, *Brgt., Pl. LXX, Figs. 5–9.*

Brgt., Hist. d. veget. foss., p. 470, Pl. CXLII. Gold., Fl. Sarræp., II, p. 50, Pl. VIII, f. 31. Ll. and Hutt., foss. Fl., I, Pl. LVII, LXXI. Lesqx., Geol. of Penn'a, 1858, p. 873. Schp., Paleont. veget., II, f. 94, Pl. LXVIII, f. 9.

Sigillaria monostachya, Ll. and Hutt., l. c., 1, Pl. LXXII.

S. alternans, ibid., Pl. LVI. Gold., Fl. Sarræp., p. 50, Pl. IX, f. 5–8. Gein., Verst., p. 47, Pl. VIII, f. 2.

Costæ not as large as in the former species; furrows less distinct; leaf-scars reniform, emarginate at the top, enlarged on the sides, rounded at the base, not or scarcely angular; vascular scars, three, the medial large, punctate, the lateral ones inflated, semi-lunar, diverging obliquely downward; subcortical scars double, vertically oval, rarely contiguous, deformed in many ways.

The difference in the characters of this and the former species is clear enough when one has on hand good corticated specimens with the reniform impressions as in f. 5. But corticated specimens of this species are still more rarely found than those of *S. lævigata*, and in a decorticated state, the deformed scars of both species are often indifferently referable to one or the other species. Brongniart describes the subcortical scars as geminate and Schimper as joined in the middle. This last character is scarcely if ever remarked upon the American specimens which, in the decorticated state, have the scars double and distinct, f. 6, like those of *S. alternans*, as figured by Ll. and Hutt., l. c., Pl. LVI, and by Gold., l. c., f. 5. In older stems they become more distant proportionally to their enlargement as in f. 8 of our plate, which is comparable to that of Geinitz, l. c., Pl. VIII, f. 2, and then more and more distant as in f. 7, having between them a kind of depression with opposite curved lines like lateral leaf-scars. F. 9, with cicatrices double, upraised, vertically rhomboidal, coarsely deeply striate across, each marked in the center by a round small cavity, probably also represents a peculiar deformation of the scars of this species caused perhaps by long exposure to atmospheric action near the base of the trunks. To give a complete representation of all the variations of these scars, observable sometimes upon a same large specimen like those in Mr. R. D. Lacoe's collection, would demand indeed a large number of plates.

Habitat—Extremely common at some localities, especially in the anthracite basin of Wilkes-Barre, Pittston, Pottsville, New Philadelphia, etc. Rare in the western bituminous coal fields.

§ 4. SYRINGODENDRON.

Cortex costate; vascular scars united in one.

Schimper considers the species of this group as representing decorticated stems of *Sigillaria*. This opinion may be right; but as these forms have not been identified with species known by their cortical cicatrices, their definite relation is unknown. I describe them under this separate section as it has been generally done by authors.

SYRINGODENDRON PORTERI, *Lesqx., Pl. LXX, Figs. 1–1b.*

Geol. Rept. of Ill., IV, p. 448, Pl. XXVII, f. 4–6.

Stems large, indistinctly costate; ribs narrow, scars in vertical rows, close, small, circular in outline; vascular scars punctate, covered by a deep convex semi-lunar impression; space between the scars irregularly striate.

The specimens from which this species has been made are fragments of trunks preserved in their cylindrical shape, one ten, the other twenty centimeters in diameter. The scars are small, one millimeter in both directions, round, when seen without magnifiers, but really composed, as seen f. 1*a*, 1*b*, (enlarged), of transversely oval cicatrices with a central punctate vascular scar traversed, either in the middle or above, by a deep semi-lunar depression giving to the cicatrices the shape of an eye half covered with its lid, as in *S. palpebra*, Daws, Dev. plants, Quart. Journ. Geol. Soc. 1862, p. 307, Pl. XIII, f. 12, whose scars are vertically two centimeters distant.

The surface of the specimens is apparently decorticated, or at least deprived of its epidermis; no part of coaly matter remains attached to it. I cannot relate this plant to any species of *Sigillaria* described. It might be compared to the decorticated surface of *S. tessellata*. But the scars are too close, scarcely one millimeter distant vertically; while measured from center to center, even in the small branches of this last species, the scars are at least three times as distant. One of the specimens which was found in connection with those described above, but which I have not seen, is said to be abruptly strangled and reduced by contraction to half its diameter. This deformation is sometimes seen upon stems of *Stigmaria*, for example, in the fragment described below as *Stigmaria stellaris*, Lesqx., and more distinctly in *S. ficoides*, Goepp. Perm. fl., Pl. XXXV, f. 2.

Habitat—Found at Eugene, Ind., and presented to the State cabinet of Ill. by the discoverer, Mr. Isaac Porter.

SYRINGODENDRON PACHYDERMA, *Brgt., Pl. LXX, Figs. 2, 2a.*

Brgt., Hist. d. veg. foss., p. 479, Pl. CLXVI, f. 1, Lesqx., Geol. of Penn'a, p. 873; Geol. Rept. of Ill., II, p. 451.
Sigillaria tessellata (decorticated), Schp., Paleont. veget., II, p. 82.

Ribs narrow, highly convex; furrows deep, carinate; subcortical scars broadly cuneiform, emarginate at top, obtuse at the base, with a central irregularly circular *mamilla; cortex a thick coating of coal whereon the position of the scars is indicated by small oval mamillæ.*

The ribs are often narrower than in our figure, from six to ten millimeters broad; the cortex is also generally thicker, one and an half to five millimeters; the ribs are highly convex and the furrows very deep. The subcortical surface is rugose, striate lengthwise by thin lines undulating around the scars and narrowing in bundles between them, as in f. 2. The cicatrices, three millimeters long, two millimeters broad, are obcordate, with medial small round mamillæ joined by narrow inflated lines to the upper borders of the cicatrices, f. 2*a*, as seen on well preserved specimens.

The reference of this form to *S. tessellata* is contradicted by the highly convex ribs. The subcortical scars, compared with those of *S. tessellata*, Pl. LXXII, f. 3, appear also far different in shape and size.

Habitat—The species is especially common in the anthracite basin of Penn'a; Trevorton, Pittston, Wilkes-Barre. Rare in the Western coal measures. There is a specimen of it in the State cabinet of Ill. without indication of locality.

SYRINGODENDRON BRONGNIARTI, *Gein.*, *Pl. LXX, Figs. 3, 3a, 3b.*

Sigillaria Brongniarti, Gein., Verst., p. 47, Pl. VII, f. 3, 4. Schp., Paleont. Veget., II, p. 97.
Syringodendron pes capreoli, St., Fl. d. Vorw., I, p. 22, Pl. XIII, f. 2.
Sigillaria pes capreoli, Gein., l. c., f. 5.

Ribs flat, separated by an obtuse scarcely marked furrow; subcortical scars oval, enlarged on one side, mucronate at the apex, narrowed at the base; vascular scars round, eccentrical, mammillate.

The bark is thin, the lower surface distinctly striate, the upper bark also, but coarsely and irregularly so, with very small oval papillæ indicating the position of the vascular scars.

Habitat—Two specimens, partly represented in Atl., are in the Mus. Comp. Zool., of Cambridge, both obtained from the lower coal bed of Trevorton.

SYRINGODENDRON CYCLOSTIGMA, *Brgt., Pl. LXX, Figs. 4, 4a.*

Brgt., Hist. d. veg. foss., p. 480, Pl. CLXVI, f. 2, 3. Lesqx., Geol. of Penn'a, 1858, p. 873.

Sigillaria cyclostigma, Gein., Verst., p. 46, Pl. VI, f. 4, 5.

Ribs plano-convex; furrows deep, canaliculate; surface very thinly, undulately lineate; cicatrices circular, emarginate at the upper border; vascular scars round, large.

The figure represents a decorticated surface. The ribs, twelve millimeters broad, separated by deep furrows, are thinly undulately lineate, far more obscurely than figured in Brgt., l. c. They are also narrower. The specimen may represent a different species, though it is evidently referable to *S. cyclostigma*, as figured and described by Geinitz, l. c. Goldenberg has also under the same name, Fl. Sarræp., Pl. VIII, f. 29, differently represented the species. Hence it is far from being satisfactorily established.

Habitat—As figured by Geinitz, the form is common in the anthracite basin of Penn'a., especially at Trevorton. It is also not rare at Pittston. One specimen referable to it is in the State cabinet of Ill., from Alton.

Species imperfectly known or of uncertain relation.

SIGILLARIA VANUXEMI, *Goepp.*

Hall, Rept. Geol. of New York, p. 184, f. 51 (not named). Gœp., Ubergsg. fl., p. 543. Daws., Quart. Journ. Geol. Soc., 1862, p. 307, Pl. XII, f. 7.

Areoles hexagonal, longer than broad, contiguous; vascular scars indistinct, in the middle of the areoles; bark thick; subcortical surface distantly obscurely ribbed, its scars oblong, oval, placed in the furrows; woody axis longitudinally sulcate.

The above description is from Dawson, who has represented the specimen, l. c. He remarks on it, that it is a sandstone cast, fifteen centimeters long, imbedded among brachiopodous shells. The bark is in a coaly state, and the woody axis, though flattened, is quite manifest, and still retains some carbonaceous matter. It approaches *S. minima*, Brgt., but is smaller and not ribbed, in which last respect it resembles *S. elegans*, Brgt., of which it may be regarded as a diminutive Devonian prototype.

Habitat—Found at Allen's quarry, near Oswego, N. Y., in the Chemung group.

Sigillaria simplicitas of Vanuxem, Rept. Geol. of New York, p. 190, f. 54, is a species with slightly rugose elevated ribs and indistinct leaf-scars, therefore undeterminable. It comes from the Hamilton group, near Buffalo, N. Y.

SYRINGODENDRON GRACILE, *Daws.*

Quart. Journ. Geol. Soc., l. c., p. 308, Pl. XIII, f. 14.

Ribs narrow; scars long, elevated, oval; vascular scars three in vertical lines.

According to the description of the author, the ribs are about two millimeters broad; the scars vertically one centimeter distant; the bark marked with delicate striæ, converging to the areoles. The subcortical surface is finely transversely striate, and the scars appear as elongated depressions.

Habitat—Species described from a small fragment of the bark on a slab from the Hamilton group of Akron, Ohio.

DIDYMOPHYLLUM (*Goepp.*), *Daws.*

Trunk arborescent, cylindrical; leaves double, united at the base, disposed in spiral order, appressed (Goepp.); *areoles prominent, reniform, each resembling a pair of small areoles attached to each other.* (Daws.)

The description by Goeppert is given in Gatt., II, p. 35, for *D. Schottini*. It is completed by Dawson, Quart. Journ. Geol. Soc., 1862, p. 309, for the following species.

DIDYMOPHYLLUM RENIFORME, *Daws.*

Ibid., p. 309, Pl. XIII, f. 15.

Same characters as the genus.

The areoles are about one millimeter in transverse diameter, horizontally seven millimeters distant, and five vertically, in a stem two centimeters in diameter.

The author adds: I believe it to have been a slender stigmaroid root or rhizome, sending out rootlets in pairs instead of singly.

Habitat—It occurs as a cast, with the thin coaly bark in part preserved, and is from the Hamilton group, near Skaneateles lake, New York. In Prof. Hall's collection.

DIDYMOPHYLLUM (SIGILLARIA) OWENII, *Lesqx.*, *Pl. LXXIV, Figs. 10–10b.*

Sigillaria Owenii, Lesqx., Geol. Rept. of Ill., IV, p. 498. (Incorrectly described for measurements.)

Trunks large, not costate; leaf-scars double, transversely oval, narrowed at the inside corners, joined by a deep, slightly arched line or groove; vascular scars small, narrow, oval central tubercles; surface between the scars regularly and finely wrinkled; roots obliquely diverging from the base, soon horizontal, marked with round stigmaroid areoles.

This species is represented by three specimens—trunks of standing trees, discovered by Dr. Dale Owen, and transferred to his cabinet with the roots still attached to them as they were found in place.

The largest of these trees, figured in a very reduced scale,* is decorticated, nearly forty centimeters in diameter, cylindrical to the base, where it enlarges and divides into nine branches or roots, simple or forking, rapidly narrowed to the part, where they are broken. The largest of these branches measure at their point of union to the tree about fifteen to eighteen centimeters in diameter, and at their broken end, at a distance of thirty-five centimeters from the base, they are only five to seven centimeters across.

The surface of the trunks is not costate, but distinctly finely rugose lengthwise; the leaf-scars disposed in spiral order or in quincunx, are double, about one centimeter distant both ways, oval, rounded on the outside, narrowed to the inside borders where they are joined by a transverse deep linear groove, each measuring three and a half millimeters horizontally, two and a half vertically, including the inflated borders. The space between them or the length of the furrow joining them horizontally from corner to corner is two millimeters, giving to the whole scars a transversal width of one centimeter.

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* I have used for the description a beautiful figure of one of the trunks of Dr. Owen. It had been kindly prepared for my use by his draughtsman, Mr. Cappelsmith, of New Harmony. I hope to have this figure represented in a future publication.

I remarked in the description of this species, l. c., that these leaf-scars were a miniature representation of a pair of spectacles. I should have added overturned, for the line which unites both parts of the leaf-scars is slightly concave.

At the point where the trunk begins to enlarge, the leaf-scars, gradually closer, become united in one and are triangular or transversely oval, f. 10*a*, and then lower down or upon the roots, they gradually pass to round mamillæ, true stigmaroid scars, with inflated borders and large central vascular points, f. 10*b*.

As *Stigmaria* is generally considered by authors as the root of *Sigillaria*, this species should be named *Sigillaria Owenii*. But the trunk is not costate, the scars not contiguous, but double, as in the genus *Didimophyllum*, described by Dawson for the former species. In a decorticated state, the base of the leaves of *Didymophyllum* remains attached to the scars in the form of protuberances pointed or emarginate, as in *D. schottini*, Goepp., Gatt., l. c.

Schimper considers this last species as identical to *Knorria longifolia*, Goepp. (*var. of K. imbricata, St.*), which for some authors is a mere form of a *Lepidodendron*. We have therefore to decide the relation of the trunks described here between four or five different genera. They are certainly not referable to *Stigmaria*, though they bear stigmaroid roots. I have not seen any trace of leaves upon the specimens of Dr. Owen, nor do I see any in the figure of Dawson and of Goeppert representing *Didimophyllum*. These only show that the leaves of this genus, enlarged at the base, were joined to the stems by two distinct vascular scars, and the cortex covering them merely marked by small protuberances like those of *Cyclostigma*, not pointed, however, nor areolate at the top, but obtuse and more or less distinctly emarginate. These characters are not observed, as far as known, upon any species of *Knorria*. As the relation of *Didymophyllum* to *Sigillaria* is indicated by the stigmarioid roots, we have to admit that *Stigmaria*, considered as roots, belong to plants of different genera and not merely to *Sigillaria*. This affords the opportunity to consider the nature of *Stigmaria* as I do it here below.

Habitat—Near New Harmony, Ind. Clay beds in the upper part of the coal measures.

Stigmaria, *Brgt.*

Floating stems or roots, generally growing horizontally, distantly dichotomous; branches long, scarcely variable in size in their whole length, sub-cylindrical or compressed; pith, a woody cylinder, often eccentrical, composed of fascicles of vessels disposed star-like; *leaves long, tubulose, linear when flattened, leaving after disruption, on the surface of the stems, round scars composed of two concentrical rings with a central umbonate mamilla pitted in the middle by a punctiform vascular scar.*

I consider *Stigmaria* as originally representing floating stems becoming roots under peculiar circumstances. The above description essentially refers to the stems. When attached to trunks as roots, Atl. Pl. LXXIV, f. 10 and 11, the divisions are more repeatedly dichotomous, distinctly narrowed downward; the axis or pith is central and the leaf-scars more irregular in position.

The remains of *Stigmaria*, the most common of the vegetables of the coal measures and distributed from the lowest to the upper strata, have from the first and for nearly a century occupied the attention of phyto-paleontologists. The exposition of the views of the authors on the characters of this plant would fill a volume

As my opinion on the double nature of *Stigmaria* is generally contradicted, I will briefly expose the reasons of my belief, in considering the growth of these peculiar plants, their distribution, the part they have had in the formation of the coal and their different mode of action, indicated by the circumstances where their remains are found.

Fragments of *Stigmaria*, trunks, branches and leaves, are generally found embedded in every kind of compound, clay, shales, sandstone. coal, even limestone, in carboniferous strata, or rather from the Devonian to the Permian. They are always in a large proportion, far above that of any other remains of coal plants, especially of those of *Sigillaria.*

If it is not proved that *Stigmaria* remains have been observed in more ancient strata than those of *Sigillaria*, we know at least that *Stigmaria* has persisted in the permian formations of Europe for a long time after the disappearance of *Sigillaria.* For ten different forms of *Stigmaria* are described by Goeppert, in his Permian Flora, as varieties of *S. ficoides*, from as many and far distant localities, while this author has seen, in this formation, remains of only two species of *Sigillaria* found at a same locality. Prof. Schimper mentions an analagous circumstance from the sub-conglomerate (Grauwacke) coal measures of the Vosges, where the strata are filled with innumerable remains of *Stigmaria*, and where no fragments of *Sigillaria* have ever been found.*

All the geologists who have examined the distribution of the carboniferous measures and the composition of the strata have remarked the predominance of *Stigmaria* in the clay deposits which constitute the bottom of the coal beds. As the remains of *Stigmaria* are always found in that peculiar kind of clay and also in the intervening silicious beds generally called clay partings, without any fragments of *Sigillaria*, it has been supposed that these clay materials were merely a kind of soft mould where the *Sigillaria* began their life by the germination of seeds and there expanded their roots, while their trunks growing up did contribute by their woody matter the essential composition of the coal formed above the clay beds. This opinion has an appearance of truth indeed. But how to explain the fact that beds of fireclay twenty to thirty feet in thickness are mostly composed of *Stigmaria*, or filled from the base to the top with remains of these plants, stems and leaves, without a fragment of *Sigillaria* ever found amongst them and without any coal above? Roots cannot live independently of trunks or of aerial plants. According to the opinion of some botanists, the rhizomas of species of Lycopodiaceæ and Equisetaceæ may have for a long time an independent life, but it is as yet not positively ascertained whether they are true rhizomas or creeping stems. They have rootlets penetrating the soft mud upon which the branches are trailing, as in *Lycopodium inundatum*. In my opinion they are true stems.

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* Terrain de Trans. des Vosges, p. 324.

Large surfaces of rocks formed of the bottom clay of the coal, hardened by metamorphism, are seen in Pennsylvania entirely covered with stems and branches of *Stigmaria*. The stems, very long, nearly of the same size in their whole length, rarely forking, crossing one upon another in all directions, cover the rocks with their leaves still attached to them in their original disposition in right angle. They have evidently the same position and distribution as during their growth, and there, over the whole exposed surface of the rocks, an acre or more, nothing is seen, either in any modification of the size of the stems or in their direction, which might indicate the rooting process or the axis of a trunk.

As seen from their fragments, the *Stigmaria* stems are not exactly cylindrical, but inflated upward from the sides of the pith, which is eccentrical and placed under the coating of cellular tissue which composes the substance of the stems and cortex. The pith is thus exposed naked on the under side of the stems, and the leaves come out from the sides and the upper surface only. This conformation shows that the stems of *Stigmaria* were floating or expanding at the surface of soft muddy flakes, and independent of the growth of trees.

The bottom clay, which underlies in various degrees of thickness most of the coal strata, has generally about the same chemical composition, and contains especially a large proportion of silica. A silicious clay underlies the beds of lignitic coal of the tertiary and also the peat deposits of our epoch, which are merely coal beds in an incipient state. This clay is formed at our time by the decomposition of aquatic plants, *Confervæ*, *Characeæ*, etc., with the addition of moluscan life. It is generally when an impermeable bottom has been formed to the basins by the subaquatic vegetation that aerial or woody plants appear, and either floating or attached by their roots to the bottom, begin the deposition of the combustible matter or wood by the heaping of their remains. At the coal epoch *Stigmaria* has played the part of the aquatic plants, and prepared, by the life and the decomposition of its stems and leaves, the beds of silicious clay where their remains are so abundantly found. The clay partings of the coal beds formed of *Stigmaria*, even the lamellæ of coal, where the bark of *Stigmaria* is discernible in its discoid leaf-scars, as it is very often the case, are silicious.

At the present epoch some kinds of plants inhabiting the swamps have floating stems. Their mode of vegetation is analagous to that of *Stigmaria.* Expanding their loose stems on or below the surface of the water, they gradually fill the ditches by their interlacing branches, and do not bear any flowering stems as long as they remain immersed. Species of *Utricularia* are of this kind. For example, *U. intermedia*, Hayne, continues its subaquatic life for years, filling ditches and canals with the detritus of its decomposed floating vegetation. It fructifies only out of the ditches or out of water in wet sand, and there the stems bear true roots, penetrating the ground by oblique or vertical ramifications.

These plants present an illustration of the mode of growth and the nature of *Stigmaria.* The stems could grow independent for a considerable length of time as floating and sterile, or bear erect flowering stems or trunks when the ground was solid enough to support trees.

The process of transformation of floating sterile stems passing into trunks bearing roots is not easily explainable. We see, however, in a very reduced scale, the same phenomenon reproduced on a number of semi-aquatic plants of the present time—the Lycopods—the mosses especially. Species of *Hypnum*, *Sphagnum*, etc., for example, which greatly contribute to the growth of the peat, have rarely fruiting pedicels when they live immersed or floating. It is only when, by prolonged vegetation, they have formed a compact floating carpet at the surface of swamps, of bayous, even of lakes, that they bear fruits abundantly, in capsules borne upon pedicels long enough to sustain them above water. The process of fertilization may result either from seeds distributed everywhere, and which take root only where the ground is solid enough to support the stems above water, or by a kind of knotting of the more compactly entangled stems, as we see it in floating species of *Uvularia*. The stems, then, change the horizontal growth into the vertical, and become trunks of *Sigillaria*, *Didymophyllum*, perhaps even of *Lepidodendron*.

Goldenberg has exposed about the same views as a result of long researches on the coal plants of Saarbruck. As confirmation of his opinion that *Stigmaria* is a plant *sui generis*, he has found small tubercles or capsuliform bodies in the angles of bifurcation of the stems. I have never seen any bodies of this kind in the same position, but have observed bladder-like tubercles at the end of the leaves, as represented Pl. LXXIV, f. 12 and 13. The leaves, here, are not attached to the stems, but they were found in beds of clay containing only remains of *Stigmaria*, and the character of the leaves is easily recognizable. That these tubercles may be organs of reproduction, I cannot affirm. They are variable in size and shape and have been sometimes described as fruits. Corda Beitr., Pl. XII, f. 1, represents a branch of *Stigmaria* bearing leaves, one of them gemmifer or with an oval tubercle at its end

Brongniart, however, admits that the observations of Hooker and Binney show beyond a doubt that *Stigmaria* are roots of *Sigillaria*. But Schimper, considering the regularity of ramification, the mode, disposition and disarticulation of the leaves, characters which are not found in any other vegetable type, supposes that those plants may rather be rhizoma than roots.

I believe that the views which I have exposed above may unite all the differences of opinion. *Stigmaria* may represent roots. In this case the plants have characters somewhat different from those given in the generic description; the pith is central, the leaf-scars irregular in position. They may be also floating plants, or according to Schimper's supposition, rhizomes or adventive stems of *Knorria* and *Lepidodendron;* for this author adds to his remarks on the Grauwacke of the Vosges, filled with a prodigious quantity of fragments of *Stigmaria*, without trace of any of *Sigillaria*, that these strata contain abundant remains or trunks of *Knorria* and of *Lepidodendron.*

The specific characters of floating plants or rhizomes are generally ill defined. This remark is especially applicable to *Stigmaria*, whose remains easily recognized by the round scars of the surface, can scarcely be specifically determined; for these scars are all of the same form, mostly of the same size, and disposed in a more or less distinct and regular spiral order. That these plants are referable to a large number of species is easily admitted in considering the number of species of *Sigillaria* to which these vegetables are referred. However, the European authors generally describe the forms as mere variety of *Stigmaria ficoides.* This matter is unimportant. I have followed here the nomenclature admitted by Goeppert, Schimper, etc.

Stigmaria ficoides, *Brgt., Pl. LXXIV, Figs. 1, 11, 12, 13.*

Brgt., Classif. d. veg. foss., Pl. I, f. 7, (1822); Prod., p. 87. Ll. & Hutt., Foss. fl., Pl. XXXI–XXXVI. St., Fl. d. Vorw., II, Pl. XV, f. 4–5. Corda, Beitr., p. 32, Pl. XII, XIII, f. 1–8. Gein., Fl. d. Kohl. v. Hain., p. 59, Pl. XI, f. 1, 2. Goepp., Perm. Fl., p. 197, Pl. XXXIV–XXXVI. Gold., fl., Sarræp., III, p. 17, Pl. XI–XIII. Lesqx., Geol. of Penn'a, 1858, p. 870. Geol. Rept. of Ill., II, p. 447. Schp., Paleont. veget., II, p. 114, Pl. LXIX, f. 7–9.

Variolaria ficoides, St. l. c., I, p. 24, Pl. XII, f. 1–3.

Ficoidites furcatus, F. verrucosus, Artis, Antedil, Phytol., p. 3, Pl. III.

Phytolithus verrucosus, Martin., Petref. Derb. Pl. XI, f. 12, 13. Parkins., *Organ. Rem., I, Pl. III, f. 1. Steinh., Trans. Am. Phil. Soc., 1, p. 268, Pl. IV, f. 1-4.**

Stems of medium size, dichotomous, branches horizontally diverging, slightly rugose; leaves of various lengths, simple, tubulose or flat and linear; leaf-scar circular.

Some authors, Artis, Corda, etc., represent the leaves as sometimes forking near the top. I have never seen any of this character. The leaves are smooth, diversely plicate by compression, tubulose at least near the base. Even sandstone strata are sometimes filled with fragments of leaves of *Stigmaria*, all cylindrical. The leaves also are indicated by authors as about thirty centimeters long, or less. I have seen them at least twice as long. They are variable in thickness in some of the following forms described by by Goeppert, l. c.

Var. B. UNDULATA, *Goepp., Pl. LXXIV, Figs. 2, 3.*

Cortex marked by longitudinal, narrow costæ, undulating by contraction between and under the scars.

Var. C. RETICULATA, *Goepp.*

Cortex reticulate-striate around the scars.

I have not yet observed this form figured by Goepp. Gatt., I, II, Pl. IX, f. 11.

Var. D. STELLATA, *Pl, LXXIV, Fig. 4.*

Cortex marked by short broad impressions, diverging star-like from the scars.

Var. E. SIGILLARIOIDES, *Goepp.*

S. irregularis, Lesqx , Geol. of Penn'a, 1858, p. 870, Pl. II, f. 4.

Cortex longitudinally costate by deep nearly parallel striæ slightly flexuous between the scars.

It is much like var. B, with costæ less undulate.

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* Besides the works quoted above, one may read with instruction, details of structure in Brgt., Arch. d. Mus. d' hist. nat., 1839. Goepp., Gatt., 1, 2, pp. 13-29. Dr. J. D. Hooker, struct. of *Stigmariæ*. Mem. Geol. Surv. of the U. Kingd., II, 2, p. 436, etc., Pl. II, (1847.) E. W. Binney (Proc. Geol. Soc., Quart. Journ, XV, p. 76, Pl. IV, (1858.)

Var. F. INÆQUALIS? *Goepp.*

S. radicans, Lesqx., Geol. of Penn'a, 1858, p. 870, Pl. II, f. 2.

Scars unequal in size, indistinctly marked, surface obscurely lineate.

The specimen is a fragment whose surface is partly erased and the scars irregular in shape and disposition.

Besides these varieties, I consider as specifically characterized the following forms:

S. UMBONATA, *Lesqx., Pl. LXXIV, Fig. 8.*

Geol. of Penn'a, 1858, p. 870.

Cortex smooth or marked with undulating narrow costæ; scars twice as large as those of S. ficoides, highly convex, umbonate.

I have rarely found this form; the longitudinal costæ are narrow, more generally effaced.

Habitat—Mammoth vein near Pottsville, Penn'a.

STIGMARIA AMOENA, *Sp. nov*

Surface transversely rugose, irregularly costate lengthwise; scars small, distant, in irregular spiral order.

The scars are finely marked upon a minutely transversely wrinkled surface; the ribs are superposed per pieces, or discontinued here and there between the scars; the scars are exactly round, two millimeters in diameter, twelve millimeters distant. Comparatively to their size, the tubercles are more distant than in any other form of the genus; the borders are more distinctly inflated.

Habitat—I have seen two specimens of this fine species, one from Rauch Gap, Penn'a, Mammoth vein; the other from the nodules of Mazon creek.

STIGMARIA STELLARIS, *Lesqx., Pl. LXXIV, Figs. 5, 7.*

Sigillarioides stellaris, Lesqx., Geol. Rept. of Ill., IV, p. 450, Pl., XXIX, f. 3.

Stem large, cylindrical, irregularly strangled; scars in regular quincunxial order, small, round or angular, with-

out distinct vascular points; surface finely wrinkled by parallel lines diverging star-like from the scars.

Fig. 7 is a copy of the specimen in a reduced scale, about one third. The trunk, which I consider a part of a rhizoma, is fifteen centimeters in diameter, narrowed to one end and crossing the shale obliquely. The leaf-scars are upraised above the surface, covered by coaly matter obliterating the central scars and also the outside borders, which are irregularly round; the cortex is narrowly wrinkled by bundles of lines traversing from scars to scars, or disposed star-like around them.

By the alternately contracting and enlarging of the fragment, which is also somewhat narrowed at one end, this specimen represents rather a rhizoma than a floating stem. It is referable to the section established by Grand 'Eury, under the name of *Stigmariopsis*, for a group of *Stigmaria* which he considers as roots of *Syrigodendron*. The peculiar rugosities of the surface seem to indicate the relation of this species to *Sigillaria monostigma*, while the small transversely oval scars of f. 5 have the characters of those seen at the base of the trunks of *Didymophyllum Owenii*, in their transition from scars of *Sigillaria* to those of *Stigmaria*.

Habitat—Shale of the coal of Morris, Ill.; Mr. Jos. Even.

SIGILLARIOIDES, *Lesqx.*

Fragments of roots bearing stigmarioid leaves attached to sigillarioid rhomboidal scars.

SIGILLARIOIDES RADICANS, *Lesqx., Pl. LXXV, Fig. 6.*

Geol. Rept. of Ill., IV, p. 449, Pl. XXXI, f. 4.

Fragment of a root narrowed to the base; scars in irregular order of disposition, transversely rhomboidal or triangular in outline, obscurely mammillate at the top, with a central vascular point; leaves tending downward, flat, linear, marked by a bundle of vessels passing into them as a distinct medial nerve.

The obscure mamillæ above the scars have somewhat the form of the basilar remains of leaves of *Knorria* when half destroyed by erosion. As seen from the leaves still attached to the scars, this is a mere tumescence, without distinct relation to the leaves. In considering the triangular shape of the scars, this fragment seems referable to *Sigillaria monostigma* as its root. It has, however, no relation of characters with the former species.

Habitat—Mazon creek, Ill., in nodules.

Roots of uncertain relation.

PINNULARIA, *Ll. & Hutt.*

This generic name represents roots or rootlets diversely divided in filaments of various length and thickness. The characters of these plants are variable and transient upon a same specimen, and their description is a matter of little interest when it cannot be completed by figures.

Lindley and Hutton have described *Pinularia capillacea*, Foss. fl. II, Pl. CXI. It is part of a root pinnately divided in linear filiform branches. I have myself recorded in Geol. of Penn'a, 1858, a number of these forms, p. 878, Pl. I, f. 9; Pl. XVII, f. 13–20, as *P. calamitarum*, *P. pinnata*, *P. ficoides*, *P. horizontalis*, *P. capillacea* and *P. confervoides*, and in Geol. Rept. of Ark., II, p. 313, Pl. V, f. 9, *Rhizolites* (*Pinularia*) *palmatifidus*, Pl. LXXV, f. 9, in order to give an idea of the characters of this kind of organism. They are referable to divers families of the coal plants and should be carefully observed to ascertain their connection with species known by other organs, stems, leaves, etc., already described.

Genus of uncertain relation.

SPIRANGIUM, *Schp.*

Palæoxyris, Brgt. Palæobromelia, Ett. Sporlederia, Stiehl.

Oblong or spindle-shaped bodies, formed of narrow linear leaves? interweaved or twisted in spiral, with the ends united into a pedicel which joins them horizontally or in umbels.

The above is the substance of Schimper's description of the genus under which he considers these peculiar plants, Paleont. veget. II, page 514. I have never seen any of these spindle-shaped bodies united together, but always single. As represented Pl. LXXV, f. 11 and 15 they appear composed of six leaves; in the other species their number is not determinable.

Until recently these plants had not been found lower than the base of the Permian, and their range was recorded as from this formation up to the Cretaceous. On the species described here, the celebrated author of the genus remarks: "They show that this problematic type was already in existence near the end of the Carboniferous."

Schimper should have said the beginning or the middle of that epoch, for the geological horizon of Mazon creek, where these plants are found in nodules, is referable to the lowest strata of the middle coal measures, or immediately above the millstone grit where species of the low coal, especially of *Lepidodendron*, abound, as can be seen by comparison of the table of distribution. Even one specimen has been found at Pittston, Pa., under the conglomerate ledge.

I do not hazard any hypothesis on the relation of these plants, considered either as organs of fructification or as radicular appendages like those of some species of *Equisetum* of the tertiary; their structure is unexplainable to me.

SPIRANGIUM PRENDELII, *Lesqx., Pl. LXXV, Figs. 13–15a.*

Schp., Paleont. veget., III, p. 585.
PALÆOXYRIS PRENDELII, *Geol. Rept. of Ill., IV, p. 464, Pl. XXVII, f. 10–13.*

Body narrowly spindle-shaped or obovate, abruptly acuminate, gradually narrowed to the pedicel; leaves distantly twisted, with broad square or rhomboidal spaces between them.

This species to which should be added f. 14, described Geol. Rept. of Ill., l. c. as *Palæoxyris corrugata*, greatly differs from the others by the large space between the spires of the leaves. The spaces give to the body the appearance of a small inflated bladder around which narrow thread-like leaves are twisted at a distance from each other. The surface between the leaves is of a different tissue, narrowly rugose or marked by very narrow parallel lines in the direction of the coils, f. 15*a*.

Habitat—Nodules of Mazon creek, Ill. The first specimens were contributed by Mr. Michel Prendel. I have obtained since a number of others from the same locality, especially through Mr. S. S. Strong. A specimen of the var. *corrugata*, in Mr. William Gurley's collection, also in nodules, is from Little Vermillion river, Ill.

SPIRANGIUM APPENDICULATUM, *Lesqx., Pl. LXXV, Fig. 12.*

Schp., Paleont. veget., III, p. 585.
Palæoxyris appendiculata, Lesqx., l. c., p. 465, Pl. XXVII, f. 11.

Body narrowly spindle-shaped, more elongated and equally narrowed at both ends: leaves numerous, twisted close together, broadly oblique to the axis, projecting on the borders.

The last character is apparently the result of a compression which, flattening the borders, has forced outside or crushed the folds of the leaves.

Habitat—Same locality as the former.

SPIRANGIUM MULTIPLICATUM, *Sp. nov., Pl. LXXV, Fig. 11.*

Body obovate, large, contracted to the pedicel, abruptly rounded to the top, composed of fasciculate obtuse large leaves, closely twisted in obtuse angle.

The leaves appear to have been united at the top of the body, where the end of one of them remains erect. This leaf is somewhat enlarged and obtuse, without medial nerve. The twisting in the middle of the body is close and somewhat irregular. The spindle is comparatively larger, two and a half centimeters broad in the middle, the other species scarcely measuring one and a half centimeter. The species is related by its size to *S. Munsteri* (Presl.), St., Fl. d. Vorw. II, Pl. LIX, f. 10, 11.

Habitat—Nodules of Mazon creek; communicated by Mr. S. S. Strong.

SPIRANGIUM INTERMEDIUM, *Sp. nov.*

Body long and narrow; ligaments thick, twisted like twine, interwoven in close spiral; intervals rhomboidal; pedicel long, twisted; apex gradually tapering and acuminate.

This form is represented by many specimens merely slightly variable in size. The ligaments are thick and narrow, nearly square or round, not flattened, the intervals, between the winding upraised threads on the body, are short, two millimeters, forming deeply rhomboidal areoles. The body is short, two and a half to three and a half centimeters long, seven to seventeen millimeters in diameter in the middle, the branches twisted. The inside ones, all broken toward their extremity, are three and a half centimeters long, the others, a little shorter, are gradually tapering into an acute point. All the specimens, except one somewhat broader, are of the same shape and size.

Habitat—Found in numerous specimens in the sub-conglomerate ledge of Pittston, Mr. R. D. Lacoe.

NOEGGERATHIÆ.

This order of fossil plants has been established by Brongniart, Tabl. d. genres, p. 64, on a species of Sternberg, *Noeggerathia foliosa*, described, Fl. d. Vorw., I, II, p. 28, Pl. XX, already in 1852. The species is represented by a branch, slender stem or rachis, bearing obovate alternate pinnules attached to the rachis by their narrowed base or sessile.

The relation of this plant is not indicated by Sternberg. Goeppert, who received specimens from him, described and figured it again in his Gattungen, considering it as a Fern related to *Cyclopteris*.

Brongniart, however, comparing it to species of *Zamia*, placed it between the *Cycadeæ* and the Conifers. Grand 'Eury remarks that pinnate and pinnatifid leaves having the structure of the *Cordaites* and considered as referable to *Noeggerathia*, have also in part the construction of Ferns, and in the absence of the fructifications, as yet unknown, may as well be placed with the Ferns as with the *Cycadeæ.* He nevertheless admits them in the Docotyledonous gymnosperms, a distribution followed also by Saporta.

Under the generic name of *Doleropteris*, Grand'Eury also refers to the *Noeggerathiæ* simple sessile round thick leaves, always entire, divided only by splitting, which, he says, are similar to Ferns only by their widely dilated borders. He remarks that they are sometimes found in connection with seeds. To this genus he refers *Adiantites giganteus* Goepp., Syst., p. 221, Pl. VII, a very large leaf, widening upward from a cuneate base, comparable by its shape and its nervation to *Rhacophyllum flabellatum*? St. Atl., Pl. LVII, f. 1; *Cyclopteris orbicularis*, Brgt., and perhaps *C. elegans*, Lesqx.* According to these references most of the round leaves which I have described as rachidal leaflets of *Neuropteris* should be placed in the new genus as related to the *Noeggerathiæ.* But as the cyclopterid leaves have most of all been found in connection with species of the genus *Neuropteris*, and identified with them, either by peculiar characters remarked upon leaflets of both *Neuropteris* and *Cyclopteris*, or by their attachment to pinnæ of the same genus, I do not see as yet any reason for that separation. *Cyclopteris orbicularis*, Brgt., is so like the large leaves of *Neuropteris rarinervis* which I have seen attached successively along a rachis of this Fern, that the distribution of these two species into two different groups seems really an anomaly. In *N. rarinervis*, of which I have represented a fragment with both neuropterid and cyclopterid leaflets attached to the same branch, Atl., Pl. XV, f. 3, the veins are often fibrous, filicular, or separating in hair-like filaments, a character given to the leaves of *Doleropteris* by the author, and which is so peculiarly distinct in *Neuropteris anomala*, Atl., Pl. VII, f. 1.

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* Saporta (in letters) has exposed the same views in regard to these plants, considering them in a separate family, *Dolerophylleæ* related to the *Cycadeæ*.

A large number of species described by authors as *Noeggerathia* are of uncertain affinity and apparently referable to the *Cordaiteæ;* at least, I admit them into this order. But for this opinion I have here no point of comparison. For, as yet, no species of true *Noeggerathia* has been found in the American coal measures, at least none answering to the description given by Schimper and other European authors, as plants bearing *pinnate leaves, attached to the stem by a semi-twisted base, dilated upwards, veins flabellate and dichotomous.* A few leaves only, represented Atl., Pl. IV, f. 1–3, may have their place in the *Noeggerathiæ.* The peculiar character of their nervation has some analogy to that of the *Ginkgo* or *Salisburia* of the Conifers. They are all described under the following generic name.

WHITTLESEYA, *Newby.*

Frond simple or pinnate, nerves fasciculate, confluent to the base, not dichotomous; fructifications unknown.

The author remarks on the above definition, Ann. of Sci. of Clevel., v. 1, (1853,) p. 116, that the characters of this genus cannot be fully given until other species are discovered; but that it is evident that the peculiar nervation of the plant described in it, *W. elegans*, must exclude it from all other known genera.

The leaves of these plants are of a thick texture, narrowly fan-like, truncate, undulate or dentate at the upper border, entire on the sides, rounded in, rapidly narrowing to a short petiole; the nerves parallel, composed of bundles of thread-like simple filaments, converging at the base, are separated by linear smooth intervals.

WHITTLESEYA ELEGANS, *Newby., Pl. IV, Fig. 1–1a.*

Newby., l. c., p. 116, f. 1–2b.

Pinnæ simple, thick, narrowly fan-like, rounded in, narrowing to the petiole, truncate and acutely dentate at *the upper border; veins in bundles of slender parallel filaments, converging at the base and at the apex in entering the teeth and connivent at their sharp point.*

No leaf attached to a stem has been found until now, though the specimens are extremely numerous at the only locality where the species has been found. Two, three or more leaves are often placed without any relative order of position upon pieces of slate of small size, as seen in the specimen figured. The longest pedicel I have seen is one centimeter. It is cut square at its base, as if detached from a stem. The author has seen, upon some specimens, slender branches bearing alternate petioles, which, he supposes, may be the rachis to which the leaves were attached.

The relation of this species and of the others of this genus is with *Cyclopteris digitata*, Brgt., Hist. d. veg. foss., p. 219, Pl. LXI bis., f. 2, 3, (*Ginkgo digitata*, Heer, beautifully illustrated in Fl. arct., IV, p. 40, Pl. X, f. 1–6). It is also distinctly marked with *Cyclopteris crenata*, Braun, Paleont. IX, p. 52, Pl. XIII, f. 8, which is of the same type and referable to the same group as *Whittleseya* or to the *Salisburiæ*.

The leaves of this species are mixed with a great number of fruits, *Trigonocarpus*, *Rhabdocarpus*, etc., probably derived of this or other analogous plants of the same group.

Habitat—Collected first by Mr. Ch. Whittlesey, at the mines of Cuyahoga falls, Ohio; after him by Dr. Newberry, and later by myself.

WHITTLESEYA INTEGRIFOLIA, *Sp. nov. Pl. IV, Fig: 2.*

Leaf obovate, a little narrower and abruptly rounded at the base, broadly obtuse and entire at the upper border, subcordate at the point of attachment of the petiole (broken); veins of the same character as in the first species; filaments obliterated by a thick opaque epidermis; decorticated surface irregularly lineate lengthwise.

This leaf, though much resembling those of the former species, is clearly different—by its coriaceous texture, the epidermis being thick, opaque, obliterating the veins; by the upper border which is entire and by the base, slightly emarginate at the point of attachment of a broken pedicel. Under the epidermis transformed into a coating of coaly matter about half a millimeter thick, the surface is irregularly lined as by the impression of the veins. Their fasciculate character is seen on the left corner of the leaf where the epidermis is preserved.

Habitat—Found in a lot of specimens sent by Prof. Eug. A. Smith, from Tuscaloosa, Ala.

WHITTLESEYA UNDULATA, *Sp. nov., Pl. IV, Fig. 3.*

Leaf narrowly fan-shaped, undulate at the upper border, rounded and narrowed to the base, apparently pedicellate (pedicel broken); surface erased or deprived of the epidermis, irregularly lineate.

This leaf may represent a variety of the former species, though far different in outline. The upper borders are undulate, the surface wrinkled and lineate lengthwise, the base gradually rounded to the petiole or to a point of attachment. It has, by the undulations of the borders, the facies of a small leaf of *Cordiates*; or rather of a leaflet of *Noeggerathia flabellata.* Ll. & Hutt., Foss. fl., Pl. XXVIII and XXIX.

Habitat—Found in the same lot with the former.

CORDAITEÆ.

Remains of plants referable to this order are abundant in the coal measures, in fragments of ribbon-like leaves, most rarely found in connection with the stems. For since the discovery by Sternberg of a stem bearing leaves, which was used by Corda for the analysis and illustration of his *Flabellaria* (*Cordaites*) *borassifolia*, I do not know that, until recently, any other has been found except the one represented, Atl., Pl. LXXVII, f. 3, discovered years ago in the upper Salem vein, near Pottsville, Penn'a. Now we know the *Cordaiteæ* by splendid materials, stems bearing leaves and flowers, fruits attached to stems, etc., published two years ago in the Flore Carbonifére of Grand'Eury, and for this continent by those not less valuable to science, obtained especially by Mr. I. F. Mansfield, in his coal bed of Cannelton. These American specimens have afforded the means of comparing and confirming the observations of the celebrated French author, and of adding to the *Cordaiteæ* some new generic divisions.

Besides *Cordaites*, and the fruits and flowers, *Cordaicarpus*, *Cordaianthus*, *Cordaistrobus*, I admit in this order as generic divisions, *Dicranophyllum*, Grd'Ey, *Desmiophyllum*, and *Lepidoxylon.* The relation of these last genera is as yet indicated merely by the ribbon-like shape of the leaves, a character which may be conventional only; for, further discoveries may supply specimens indicating by new and more important characters a relation to different orders of plants. This has been the case already with the *Tæniophyllæ*, formerly described in the *Cordaiteæ*, and now forcibly placed with the *Lycopodiaceæ* on account of their fructifications.

The *Cordiateæ* are now generally referred to the Dicotyledonous Gymnosperms, as intermediate in characters between the *Cycadeæ* and the Conifers. Corda, to whom we owe the anatomy of *Cordaites*, from a species described in Beitr., p. 44, Pl. XXIV and XXV, as *Flabellaria borassifolia*, compared the structure of the plant to that of *Dracæna*, and to *Lomatophloios* especially, from the characters of the pith or medular cylinder.

Sternberg had already examined this plant and referred it to Palms, while somewhat later, another specimen of this kind, with narrower leaves, is mentioned by the same author as related to the *Cycadeæ*, Fl. d. Vorw., 1, p. 39, Pl. XL. From the apparent cylindrical form of the leaves this fragment seems to have the character of *Tæniophyllum*.

Brongniart, in his tableau des genres, p. 65, proposed a new genus, *Pychnophyllum* for that *Flabellaria borassifolia*, and considering its structure as related to that of the *Sigillariæ*, the *Cycadeæ*, and the Conifers, he placed it in the *Noeggerathiæ*, between these two last families.

Goeppert, admitting the *Noeggerathiæ* as Monocotyledonous, is however of the opinion of Goldenberg, that from their flowers and fructifications they should be placed between the *Cycadeæ* and the Conifers.

Schimper places in the *Cycadeæ*, as genera of uncertain relation, *Pychnophyllum*, Brgt., for the description of *Cordaites* species, and a new genus, *Psygmophyllum* for that of the *Noeggerathiæ*.

Weiss (1869) says that the inflorescence and fruits of these plants relate them to the *Cycadeæ* and the Conifers, but that by their leaves their affinity is with the monocotyledonous, while Heer (1876) admits them in the Conifers, and Grand'Eury, to whose admirable work we mostly owe our acquaintance with these two orders of plants, the *Noeggerathiæ* and *Cordaiteæ*, places them in the Gymnosperms, after the *Sigillariæ*, thus remaining in concordance with Brongniart's opinion.

In a late work just published, *Structure Comparée, etc., Nouv. Arch. du Museum, II, 2d series*, a work as remarkable by the precision of the anatomical details as by the extent and accuracy of the comparative researches, the author, M. B. Renault, resumes the results of the microscopical analysis of the *Cordaites* in an exposition of the characters of their woody cylinder and pith, their leaves, their flowers, their fruits, and concludes, p. 323, that these plants belong to the order of the *Cycadeæ*, of which they constitute a distinct family. The exposition of the characters and the deduction derived from them are so clear that this conclusion seems indisputable.

CORDAITES, *Ung.*

Trunks of large size, irregularly branching, formed of a large medular canal or pith, marked on the outer surface by transverse narrow parallel simple ribs rarely joined by divisions, covered by double or triple layers of wood and bark converted by fossilization into thin layers of coal; leaves in spiral order, more or less distant, ribbon-like, of various length and width, linear or more generally gradually enlarging upward, obtuse, entire or undulate and split at the apex; borders curving to the ses-

sile or semi-embracing somewhat inflated base; surface marked lengthwise by primary and secondary parallel simple nerves, generally more distant in the middle of the leaves and slightly inflated towards the base; flowers in racemes from the axils of the leaves; fruits generally oval, sessile, of various size.

The flowers, when found separately, represent the old uncertain genus, *Antholites;* the fruits have been referred, until now, to different species of *Carpolites*, *Trigonocarpus*, etc. Both these kinds of organism are further considered under the name of *Cordaianthus* and *Cordaicarpus.*

The decorticated stems of *Cordaites* have been often described under the generic name of *Artisia* and *Sternbergia.*

The *Cordaites* were, generally at least, or for some of their species, arborescent plants of great size. Grand'Eury has reconstructed, on a splendid plate, Fl. Carb., Pl. D, a number of trees which he estimates twenty to forty meters in altitude, their trunks forty to fifty centimeters in diameter. The divisions are oblique, the branchlets small, with crowded, imbricated short and small leaves, Atl., Pl. LXXVIII, f. 2, showing how far different are the leaves upon branches of different age, and how great is the difficulty of their identification when they are merely represented by fragments, or even when entire but separated from their supports.

In this case the nervation of the leaves is the essential character applied to the specific determination of the cordaites. But, as the distance between the primary nerves and the number of the intermediate veins vary, not only in leaves of different ages, but even in the same leaf, this character is not entirely reliable.

The stratigraphical distribution of *Cordaites* like that of *Lepidodendron* and *Sigillaria*, is from the lowest subcarboniferous coal measures to the base of the Permian.

Goeppert describes *C. principalis* and *C. borassifolius* from the Permian of Silesia. I have not seen in North America any specimens of *Cordaites* from above the Pittsburgh coal. Species of the genus are extremely abundant in some localities, where their leaves, heaped and compressed in mass, are the essential constituents of whole beds of coal or of shale. The absence of branches, of fragments of stems in connection with these leaves, indicates for the plants a growth of long duration. The leaves, flowers and fruits were easily, perhaps annually, detached from the trees.

§ 1. CRASSIFOLIÆ.

CORDAITES VALIDUS, *Lesqx.*, *Pl. LXXVI, Figs. 1–2a.*

Proc Am. Phil. Soc., 1878, p. 317, Pl. XLVII, f. 1, 2.

Stem narrowly irregularly striate; leaves long, linear, half embracing the stem at base, slightly enlarging above the point of attachment marked by a subcordate scar, obscurely nerved on the upper surface; nerves simple or with a single intermediate vein.

The fragment of stem figured is coarsely nerved or thinly striate, the lines being irregular in size, here and there inflated, half to one millimeter distant. The leaves appear very long, as seen from divers fragments, one of which is thirty-five centimeters long, linear, five to eight centimeters broad. The primary nerves, three to five per millimeter, obtusely keeled, simple or with an intermediate secondary vein, are scarcely distinct on the upper surface of the leaves, but clearly seen upon the lower, where they appear more equal and more numerous. The coaly layer of the bark of the stem is about one millimeter thick. The same thickness of coal fills the place of the leaves upon their slightly concave impressions, between the upper and lower faces, and represents their thickness.

The specimen, Atl., f. 1, seems to represent the leaf as decurrent on the side. The branch is broken at the point of attachment, and the apparently prolonged side is merely the turning of the border toward the stem behind, from which the medial and lacerated part of the leaf is detached. F. 2 shows the base of the leaves as seen separated from the stem and flattened by compression. That part is deeply undulate-laciniate and the base of the laciniæ slightly inflated by fascicles of veins confluent to it. F. 2*a* represents the shape of the scars left by the base of the leaves upon large stems.

Grand' Eury seems to have seen leaves like those described above, for he remarks in a note on a sub-species of *C. borassifolius*, under the name of *C. crassifolius*, Fl. Carb., p. 216: "We do not know yet if we can refer to this type leaves of a thicker consistence, one face of which is marked by stronger nerves and alternate finer veins, while the other is more equally and definitely lined." This remark applies exactly to the nervation of the leaves of this species.

Habitat—Cannelton, Penn'a, Mr. I. F. Mansfield.

CORDAITES CRASSUS, *Lesqx.*

Noeggerathia crassa? Goepp., Uebergsg. fl., p. 220, Pl. XL.

Fragment of broad linear leaves, coarsely striate lengthwise; texture thick.

I refer to this a number of specimens whose facies resembles that of flattened stems of *Calamites*, irregularly ribbed lengthwise, often very long, always without any trace of articulations. These fragments vary in thickness from two to five millimeters; the striæ appear composed of fascicles of veins here and there inflated, sometimes buried under a thick epidermis.

I am unable to say if these fragments represent Goeppert's species, or even if they are referable to this genus. Years ago I sent to Prof. Brongniart some of these specimens, but do not know if they have been examined by the celebrated author.

Habitat—Especially found in the anthracite beds of Penn'a.

§ 2. GRANDIFOLIÆ.

CORDAITES GRANDIFOLIUS, *Lesqx., Pl. LXXVII, Figs. 1–2a.*

Proc. Am. Phil. Soc., 1878, p. 318, Pl. XLVIII, f. 1–2a.

Leaves large, of a strong texture, widening upwards and fan-like from a narrow semi-lunar base, round truncate or rounded and undulately lobed and split at the top;

nervation double; primary nerves obtuse, dichotomous or splitting, inflated, and more distinct toward the base, with one often indistinct intermediate vein.

Of this species I have not seen any stems, and all the leaves which I had for examination have the same truncate narrow base, one of them only being cut at the point of attachment in the semi-lunar form of the leaves of *Cordaites.* Among the fine specimens sent by Mr. R. D. Lacoe, most of which are too large for illustration in our plates, the outspreading upwards is marked in different degrees. One of the leaves, for example, thirty-eight centimeters long, is gradually enlarged to the rounded top, where it is sixteen centimeters wide, undulate and split in short laciniæ like f. 1. Another with the base six millimeters broad, truncate, but concave at the point of attachment, is thirty-two centimeters long and fifteen centimeters broad at the apex, or there nearly half as broad as long.

Among the specimens of this species, one bears with fragments of leaves a flowering raceme upon a long axis. The raceme is curved or flexuous in the middle, about eighteen centimeters long. The axis, two millimeters in diameter, is flat, slightly channeled in the middle, narrow, two millimeters, bearing opposite sessile oval or obovate gemmules, superposed to a few imbricated narrow scales which are easily detached, the lowest nutlets being all naked. The branch has twenty-two pairs of these fruits, the largest the basilar ones, four to five millimeters long, three and a half millimeters broad, mostly of the same size, the upper ones only slightly and gradually smaller. Besides the branch the same specimen bears scattered, nearly globular nutlets, seven to eight millimeters in diameter, slightly emarginate at the base, surrounded by a ring, and resembling *Diplotesta Grand' Euryi*, Brgt., as figured by Grd'Ey., Fl. Carb., Pl. XXVI, f. 27, or nearly similar to f. 49–50, Atl. Pl. LXXXV. But all the figures of Grd'Ey., Pl. XXVI, of *Cordaianthus baccifer* represent the fruits close and alternately disposed in short racemes, either supported at the base by imbricate narrow scales or posed in the axils of long linear bracts.

As this branch is disconnected, its reference to *C. grandifolius* as its fructification is not positive. This *Cordaites* is, however, the only one of which leaves have been found at the same locality, in a bed of shale covering a very limited area, about one square rod only.

Habitat—Sub-conglomerate ledge of Pittston, Pa., All the specimens have been found and communicated for examination by Mr. R. D. Lacoe.

§ 3. COMMUNES.

This section might be sub-divided into two groups, one for the species with large leaves, more generally found in the middle coal measures; the other for the narrow-leaved species, which appear related to those described by Grand 'Eury, under the name of *Poa-Cordaites*. Though I cannot find either in the nervation or in the basilar form of the point of attachment of the leaves, any persistent characters which could enable me to distinctly separate them, these sub-divisions are preserved for convenience.

A. Latifoliæ.

CORDAITES BORASSIFOLIUS, (*St.*) *Unger*, *Pl. LXXVI, Figs. 3–3b.*

Flabellaria borassifolia, St., Fl. d. Vorw., I, II, p. 27, Pl. XVIII. Corda. Beitr., p. 44, Pl. XXIV, XXV.

Pychnophyllum borassifolium, Brgt., Tabl. d. genres, p. 65. Schp., Paleont. veget., II, p. 190.

Cordaites borassifolius, Ung., Gen. and Sp., p. 277. Lesqx., Proc. Am Phil. Soc., 1878, p. 319, Pl. XLVII, f. 3-3b.

Leaves generally large, from five to eight centimeters broad in the middle where they appear the widest, gradually narrowing both ways, upward to the obtuse or truncate apex generally more or less deeply split, downwards to the slightly contracted semi-lunar somewhat inflated base. Nervation indistinct to the naked eyes, close, five to seven primary nerves in one millimeter, and generally one *intermediate thin veinlet; surface marked by cross wrinkles, more distinct than in the former species.*

As figured by Corda, who has given the characters of the nervation, and of the areolation, the leaves are all shorter than I have generally found them. But the branch which the German author has figured is a young one, bearing top-leaves only. I have seen in Kentucky, near Amanda furnace, a bed of clay iron ore composed mostly of remains of this species, where, amongst an immense number of fragments, there were well preserved leaves five to six centimeters broad, some very obtuse, half round at the apex, some also split into laciniæ in the middle, others narrowed at the top like that figured in Atlas. This one is cut in two, the middle part being left out from want of space. It measures, in its whole, forty-five centimeters in length and six centimeters in width in the middle, where, on the figure, the intermediate lines mark the diameter of the leaf.

Häbitat—Found in most of the beds of the carboniferous measures, from the Millstone Grit to the Pittsburg coal. Not rare at Cannelton, Pa.

CORDAITES LINGULATUS, *Grd' Ey.*

Fl. Carb., p. 218, Pl. XX.

Leaves large, gradually widening from the base to a very obtuse apex, lingulate or spatulate in outline; primary nerves distinct, at equal distance through the whole width of the leaves; intervals obtusely keeled, transversely rough, without intermediate veins.

The leaves which I refer to Grand'Eury's species are generally long, fifty centimeters or more, seven centimeters broad in the largest part toward the top, at twelve centimeters distance from the round apex and thirty centimeters from the base, which is two centimeters in width. This measure gives the exact form and dimensions of nearly all the numerous leaves which I have seen of this species. The author describes and figures it with much shorter leaves, but remarks that they are often as long as sixty centimeters. His description of the nerves, as fine and sharply defined, nearly equal, is applicable to the American specimens. In some of these, the epidermis renders the surface quite smooth and the veins obsolete in some places; but they are always distinct and sharply marked under the easily removed epidermis. The fruiting racemes of this species, attached to the axils of the leaves and generally covered by their base, are short, six centimeters long, and bear alternate round nutlets, two to three millimeters in diameter, four millimeters distant, each in the axil of a long linear bract inclined upwards, two and a half centimeters long. They have the characters of the branch of *Cordaianthus baccifer*, Grd'Ey, l. c. Pl. XXVI, f. 15, a little more distinctly round than oval.

Habitat—Boston mine, B and C seam, two and a half miles south-east of Pittston, Pa. Mr. R. D. Lacoe.

CORDAITES COMMUNIS, *Lesqx.*

Proc. Am. Phil. Soc, 1878, p. 320.

Leaves of various size, generally smaller than those of C. borassifolius, more rapidly narrowed to the base, distinctly nerved, though covered with a thick epidermis.

The largest leaf seen of this species is twenty-two centimeters long, thirty-seven millimeters broad near its top where it is broken, fifteen millimeters broad just above the point of attachment, with borders generally recurved. The primary nerves obtuse and less distinct on the upper surface than on the lower, generally three in a space of two millimeters, are separated by two to four intermediate secondary veins, a character which easily separates this species from the others of this group.

One of the specimens examined is a stem with some leaves and distinct semi-lunar scars of others already detached. It bears also a young branch with shorter closely imbricated leaves, two centimeters long. It is in the same position and direction as the one in Atl. Pl. LXXVIII, f. 2, and bears also apparently from the axils of the leaves, small gemmules (only one is distinct) covered with imbricated scales representing in a very diminutive shape *Cordaianthus gemmifer* (Atl. Pl. LXXVI, f. 5, 5*a*). These gemmules are not larger than those f. 4 of the same plate. Their mode of attachment is not seen. The stem of the species is covered by a coating of coal about one millimeter thick, with leaf-scars distinct.

Habitat—Clinton, Mo. Dr. J. H. Britts.

CORDAITES LACOEI, *Sp. nov., Pl. LXXXVII, Figs. 2–4, (this vol.)*

Leaves small, elliptical, obtuse or rounded to an obtuse acumen, with a comparatively broad, inflated base; nerves distinct; texture thick, subcoriaceous.

Of these leaves I have seen four, none attached to a stem. They vary in size from three to twelve centimeters long and from one and a half to five centimeters broad. In the largest leaves, the semi-lunar base is two centimeters across, in the others a little less. The venation is very distinct. The primary nerves are obtusely keeled, three fourths to one millimeter distant, with four to six very thin intermediate veins, as seen f. 3*a*, enlarged. The species is closely allied to *C. foliolatus*, Grd' E'y, Fl. Carb., p. 219, Pl. XXI, f. 3*a*, differing in the comparatively broader size of the leaves, the larger base, and the nervation. The substance of these leaves is also different; for, according to the author, it is thinner in his species than in *C. lingulatus*, while in the American specimens, the leaves are comparatively thick—nearly coriaceous.

Habitat—Pittston shale above coal E. Mr. R. D. Lacoe.

B. Angustifoliæ.

CORDAITES DIVERSIFOLIUS, *Lesqx., Pl. LXXVII, Figs. 3, 3a.*

Proc. Am. Phil. Soc., 1878, p. 320, Pl. XLVIII, f. 3, 3a.
C. angustifolius, Lesqx., Geol. Rept. of Ill., IV, p. 420.*

Leaves narrow, linear, half embracing at the point of attachment, imbricated at base, curved backward along the

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* Name preoccupied by Dawson, Can. Natur., 1861, p. 10.

stem, upraised in tufts at the top; primary nerves very distinct, generally at equal distance, with intermediate very thin veins; surface flat, epidermis thick.

The figured specimen has been mentioned already as the first fragment found in this country of a stem of *Cordaites* bearing leaves. The figure represents the base of the leaves a little too large, at least as seen from other fragments from different localities. The leaves are, however, extremely variable. One of them, from Clinton, Mo., measures seven millimeters at the point of attachment, is immediately enlarged above it to eleven millimeters and gradually widens upwards to seventeen millimeters at the point where it is broken, eleven centimeters from the base. Other leaves from the same locality are exactly linear in their whole length, seventeen millimeters in diameter, while others still, fifteen millimeters broad just above the point of attachment, gradually decrease in width upward. These measurements show the variations in size of these leaves not merely in regard to their relative position, but comparatively to the different parts of their length.

To this species I refer a large number of separate leaves obtained at the same locality as the specimen f. 3. Some are flat, linear, others have the borders distinctly curved down or are half cylindrical; others still are true cylinders, not larger than goose quills, seemingly coming out of a common pedicel, being often found in bundles, enlarging upwards in proportion as they open and the borders become more and more flattened. The cross section of these leaves is a circular or an oval line. Though the surface of the leaves is covered with a thick shining epidermis, the primary nerves, three or four in one millimeter, are always so distinct that they are easily counted without a magnifier. But the intermediate veins, three or four, very thin, are scarcely perceptible without a strong glass.

Habitat—Upper coal measures of Penn'a, especially the South Salem vein of Port Carbon and around Pottsville. Low coal measures of Missouri, Clinton. Middle and lower coal of Ill. Abundant at Colchester, St. John, and Duquoin.

CORDAITES MANSFIELDI, *Lesqx., Pl. LXXVI. Figs. 4–4b; LXXVIII, Figs. 1–2; LXXXVII, Fig. 18, (this vol.)*

Proc. Am. Phil. Soc., 1878, p. 321, Pl. XLVII, f. 4-4b; XLIX, f. 1, 2.

Stem with a thin bark of polished coal, indistinctly marked by the scars of the convex base of leaves, either close or more or less distant, disposed in spiral; leaves long, erect, nearly exactly linear, gradually diminishing near the top to an obtuse point, averaging fifteen millimeters in diameter, distinctly and distantly nerved; primary nerves fifteen to eighteen in one centimeter, with two to four intermediate veins; flowers composed of four sepaloid involucres, borne upon simple flexuous pedicels to which they are attached by short peduncles; fruits in large nuts sessile upon separate branches.

As seen from the splendid specimen figured here and from a number of others quite as remarkably well preserved, the species is characterized by its long erect linear leaves whose surface is marked by a distinct nervation, (1*a* enlarged double, 1*b* enlarged four times.) The leaves, rounded and narrowed to the point of attachment reduced to half their diameter, are perfectly entire and obtusely acuminate. The stems are covered with a thin coating of coaly, shining bark, where the leaf-scars are indistinctly marked as they are also upon the subcortical surface. The branches apparently form the axils of the leaves, one of which is seen f. 2, bear closely imbricated leaves proportionate in size to the length and age of the divisions. They are linear-lanceolate, obtusely pointed, with a nervation of the same character, reduced, of course, to proportionate dimensions by the size of the leaves. Another specimen bears a branch two to three centimeters thick, diverging in the same degree as the one figured, twelve centimeters long, with leaves also of proportionate size, the largest already fifteen centimeters long, all imbricated, linear-lanceolate, with the borders incurved, especially towards the top which thus appears acuminate. The nervation has equally the character of the larger leaves, the primary veins being one half to three fourths of a millimeter distant, with two or three intermediate vinelets.

Under the name of *Cordaianthus simplex*, I refer the stem-bearing flowers, Pl. LXXVI, f. 4, 4*a*, to this species, especially because the specimen was found in the same shale and in proximity to those bearing leaves, though not in connection with them. This stem is somewhat different by its slightly thicker coaly surface. The leaf-scars are indistinct, as is generally the case for this species, so that their relative position is rarely appreciable. The racemes of flowers, flattened by compression, are irregularly flexuous, with their vascular filaments distinct, as if the branches had been in an advanced state of maceration. The flowers, which appear to be male flowers, are borne upon short peduncles and pending, composed, as seen f. 1*a*, of three or four involucral thick lanceolate acute scales. The point of attachment of the elongated narrow racemes is round, inflated in the lower part, as seen f. 4*b*. Their position in regard to the leaves is not possibly seen.

All the flowering racemes of *Cordaites* figured by Grand'-Eury have the flowers, either sterile or fertile, sessile upon the branchlets. It is the same with those figured by Dawson, under the name of *Trigonocarpum racemosum*, Quat. Jour. Geol. Soc., vol. XVIII, p. 324, Pl. XVI, f. 47, which are referable to *Cordaianthus baccifer*, of Grand'Eury and with those of Weiss, Foss. fl., p. 195, f. 1, representing *Cordaianthus gemmifer*. A point of likeness only is found for the inflorescence of *C. Mansfieldi*, by the form of the flowers attached to a short pedicel and the thick raceme, in St. Fl. d. Vorw., I, Pl. XXVI, f. 2. This figure, though described without reference as *plantula debilis*, p. 33, represents evidently the flowering branch of a *Cordaites*.

As seen from the specimen bearing fruit, Pl. LXXXVII, f. 8 (this vol.), representing a branch or piece of bark of this species, well characterized by its thin shining coaly bark and the indistinct leaf-scars, the fruit is comparatively very large, obovate, six and a half centimeters long, four and a half centimeters broad above the middle. The outer envelope, testa, is a double coating of coaly matter, reduced, upon the flattened surface of the fruit, to a thickness of one millimeter, but originally twice as thick, as seen from the flattened borders of other specimens. The surface, either covered or naked, is distantly obscurely striate, more opaque and more distinctly lined under the testa. This fruit is evidently of the same kind as that figured under the name of *Cordaicarpus Mansfieldi*, Atl., Pl. LXXXV, f. 21. I have seen a number of these fruits, which differ only by their size, and this even in a small degree. The last-mentioned figure is overturned. The oval depression at the top marks the point of attachment distinctly seen upon the figured specimen recently obtained, and still attached to the slightly inflated basilar impression of the stem. This last specimen bears scattered leaves of *Cordaites Mansfieldi*, separated from the branch; but the peculiar character of its stems clearly indicates the relation of the fruit to this species. This fine *Cordaicarpus* is related to *Rhabdocarpus multistriatus*, St.

Habitat—Cannelton. Mr. I. F. Mansfield.

CORDAITES GRACILIS, *Lesqx., Pl. LXXVII, Fig. 4–4b.*

Proc. Am. Philos. Soc., 1878, p. 322, Pl. XLVIII, f. 4–4b.

Stem slender, with a rugose somewhat thick bark; leaves narrowed at the base, open or inclined backwards, distant, gradually enlarged from the base to the apex, sublinear, obtusely truncate; nervation obscured by a slightly rough epidermis; primary nerves variable in distance from one fourth to one millimeter, with one to four intermediate very thin veins.

Species allied to the former by the nervation, but distinct from it by the shape, the size, the relative positions, the direction of the leaves and the thick rough bark of the stem. The leaves are nine centimeters long, five millimeters broad at the base, one centimeter at the obliquely truncate apex. The point of attachment, f. 4*b*, is slightly tumescent, reniform.

Habitat—Morris, Ill., Mr. S. S. Strong. One specimen with broken leaves, on which the point of attachment is distinct, is from Cannelton, Pa.

CORDAITES RADIATUS, *Sp. nov., Pl. LXXXVII, Figs. 5–7, (this vol.)*

Branches small; leaves short, narrow, linear, obtuse, placed in right angle and star-like around the stems; primary nerves strong, obtuse, variable in distance; intermediate veins two to five, very thin.

There is, in the Mansfield collection, four specimens representing this remarkable species. They are all fragments of stems of various thickness, three to ten millimeters in diameter, with leaves disposed star-like and flattened upon the stone all around the axis. The smallest branch has the leaves two centimeters long and three millimeters broad, the largest has them six to eight centimeters long and six millimeters broad; another, f. 5. is intermediate, and like the large ones also, is part of a stem covered by leaves horizontally diverging, so that each section of the stem shows them placed exactly like the rays of a star. The primary nerves are very distinct, cylindrical, and immersed into the epidermis under which their impressions are concave. They vary in distance and are separated by very thin veins in number proportionate to the intervals, one to three. These veins are not discernible upon the leaves covered by the epidermis, but distinct underneath. By the nervation this fine species is related to *C. costatus*. Its primary nerves, separated by two or three veinlets, are not as thick; and the texture of the leaves is thin, the stem not costate, etc.

Habitat—Cannelton. Mr. I. F. Mansfield.

§ 4. COSTATÆ.

CORDAITES COSTATUS, *Lesqx., Pl. LXXX, Figs. 1–3; LXXXVII, Figs. 1, 2, (this vol.)*

Proc. Am. Phil. Soc., 1878, p. 323, Pl. LI, f. 1–3.
Cordaicarpus costatus, Lesqx., ibid., 1878, p. 222, Pl. III, f. 1. 2.

Stems irregularly costate by the decurring prolongation of the tumescent leaf-scars; leaves erect, narrow, sublinear, slightly enlarging upwards; primary nerves at unequal distance, three to five in a space of two millimeters; intermediate veins three to four; surface wrinkled across;

male flowers attached to narrowly oval sessile flexuous axillary racemes; fruits large, oval, slightly contracted to the tumescent point of attachment upon a narrow branch.

The stems seen of this species are not large, two to four centimeters; the leaves narrow, five millimeters above the base, gradually enlarging to one centimeter at the point where the longest (ten centimeters) is broken, none being preserved in its whole length. They are erect from a tumescent reniform point of attachment, which, narrowed and continuous downward, constitute, after disruption of the leaves, narrow carinate interrupted ridges which become sharply keeled upon old stems, as in f. 3, or form under the cortex elongated linear furrows.

The male flowers, f. 1*b*, narrowly oblong, composed of narrow linear-lanceolate scales, imbricating at the base, are sub-sessile upon long cylindrical simple peduncles, slightly inflated or as if articulate at the point of attachment.

The fruit, *Cordaicarpus costatus*, Lesqx., is a large oval nut, three centimeters long from its base to the very obtuse top, twenty-three millimeters broad, including the testa represented by the inflated border and a thin coaly layer upon the surface. The base is rounded in narrowing to the point of connection to the stem, evidently a separate branch one centimeter broad, flattened. The inflated supports of the fruits are exactly similar to those of the leaves of *C. costatus*. This is the only proof I have of their reference to this species. But as stems and leaves of this species are common in the same shale where the fruit was found, and as this character is not remarked upon any other species from Cannelton I consider the reference as authorized.

Habitat—Cannelton. Mr. I. F. Mansfield.

§ 5. SERPENTES.

Stems narrow, flexuous or serpentine, flattened at its top prolonged into a broad leaf.

CORDAITES SERPENS, *Lesqx, Pl. LXXIX, Figs. 1–4.*

Proc. Am. Phil. Soc., 1878, p. 324, Pl. L, f. 1–4.

Stem slender, flexuous or serpentine, abruptly rounded or truncate at the top in passing to a broad terminal long flat leaf-like prolongation; lateral leaves in right angle to the stems, sub-linear, narrowed to the point of attachment; nervation distinct.

The peculiar conformation of the stems is especially marked on f. 4 reduced to one sixth of the natural size. Besides the figured specimens, a number of others have been received and examined at Cannelton with the flexures of analogous shape.

The lateral leaves, five to ten millimeters in diameter, narrowed in a curve to a semi-lunar point of attachment, are nearly linear, short, the upper ones cut in flexuous laciniæ (flagellate), f. 1. The primary nerves, about at equal distances, are generally effaced near the borders of the leaves, three or four in a space of three millimeters, with three, sometimes five, thin intermediate veins. The nervation of the terminal leaves is of the same character.

The stems all slender, one and a half to two centimeters in diameter, are irregularly variable in thickness at divers parts of their length as seen f. 1, still more distinctly f. 4. The surface is covered by a double layer, the upper bark thin, easily detached, represented f. 1, 2, by flakes of coaly matter; the woody cylinder, thicker, more compact and tenacious, covering the pith, f. 3, which is transversely ribbed with the characters of *Artisia* or *Sternbergia.*

This stem, f. 3, has preserved its cylindrical normal shape. I have other fragments about of the same size, merely of the internal pith, also in a decorticated state, one among others representing its top abruptly flattened or as pinched to a flat prolongation, as would be the stem of f. 2

without its bark and its terminal leaf. This abrupt termination of the cylinder, the flagellate sub-divisions of the upper lateral leaves, f. 1, the enlarging of the terminal one, and still more the serpentine conformation of the stems, indicate the mode of vegetation of these plants. They were evidently growing flat upon the mud, expanding their leaves all around, supported by a woody cylinder, which, in reaching water, was transformed into a large probably very long floating leaf serving as a support to the stem.

Prof. Dawson has represented in Geol. Surv. of Can., 1871, Pl. III, f. 28, a branch of *Artisia* abruptly terminating into a short cone, as in the stems of this species. He considers it as probably referable to a *Dadoxilon* or Conifer. He refers also to the same genus another fragment of stem of a same character, bearing on one side a piece of thick bark like that bordering the stem f. 3. Some of the specimens from Cannelton, like the one, Atl., Pl. LXXXI, f. 2, represent larger stems referable to other species of *Cordaites*, identified as they are by the character of the fragments of bark partially covering them. There is no doubt whatever that the transversely ribbed cylinders generally described as *Artisia* or *Sternbergia* represent generally if not always the pith of plants of this family. This opinion has been discussed in the length and admitted from sufficient evidence by Renault.*

Habitat—Cannelton. Communicated in numerous specimens by Mr. I. F. Mansfield.

SPECIES INSUFFICIENTLY CHARACTERIZED.

CORDAITES ROBBII, *Daws.*

Can. Natur., May, 1861, p. 8. Dev. Plants, Quat. Journ. Geol. Soc. (1862), p. 316, Pl. XIV, f. 31a, b, c.

Leaves elongated, parallel-sided, an inch or more in width, with very delicate equal longitudinal striæ.

On this plant, the author remarks that the leaves are very unequal in size, variable in form, oblong, nearly obtuse when young, with numerous equal parallel nerves, and a smooth surface. It closely resembles *C. borassifolius*, differing by the perfectly equal nerves.

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* Struct. Comp., Nouv. Archives du Mus. II, 2d Series, p. 285, etc.

Habitat—St. John, New Brunswick. This species is not positively known from American specimens, for the author says of it, that he has seen in the New York State cabinet a fragment of leaf from the Hamilton group not sufficiently perfect to render its identification certain.

CORDAITES ANGUSTIFOLIUS, *Daws.*

Can. Natur., l. c., p. 10. Dev. Plants, Quat. Journ. l. c., p. 318.

Leaves elongated, one tenth to one fourth of an inch wide, with delicate equal striæ.

According to the author, it differs from the former, at least, in its proportionate narrowness and decided striation. He compares it to *Noeggerathia graminifolia*, Ung., "which in form and dimension it much resembles."

Habitat—Found in the Marcellus shale of New York.

CORDAITES FLEXUOSUS, *Daws.*

Quart. Journ. Geol. Soc., 1863, p. 462.

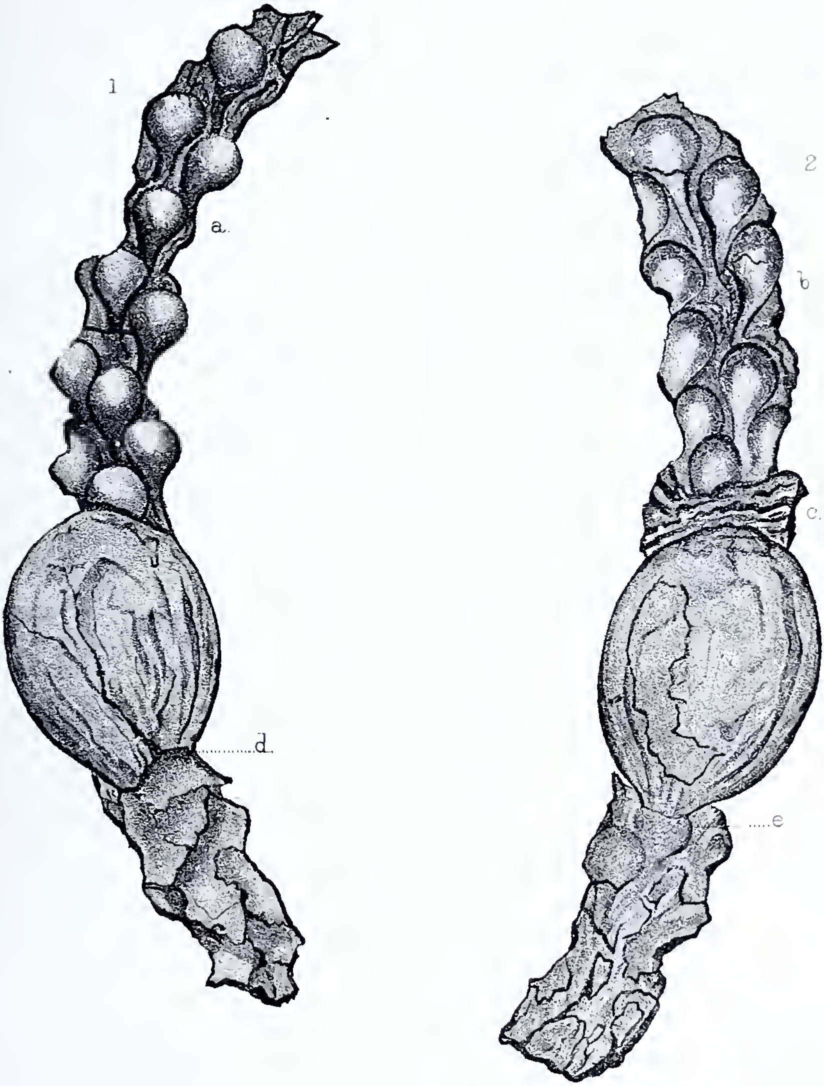
Leaves lanceolate-acuminate, broad at the base; nerves numerous, parallel, somewhat sinuous and uneven.

It has the general appearance of the leaves of *Cordaites*, but less distinct nervation, and apparently less rigidity than the other species.

Habitat—Perry, Maine.

FLOWERS AND FRUITS OF CORDAITES.

When the paper containing a description of species of *Cordaites* found in the coal measures of N. America was published, Proc. Am. Phil. Soc., 1878, we had stem-bearing leaves and racemes of flowers of species of Cordaites, but not any fruits in connection with their supporting racemes or branches. I then described the flowers under the generic name of *Cordaianthus*, proposed by Grand-'Eury, and of *Cordaicarpus*, for the fruits found detached or isolated among leaves of *Cordaites*, which were then hypothetically considered as their fructifications. Since



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CORDAITES COSTATUS, LESQX
BRANCH BEARING FRUIT

that time new discoveries have supplied materials sufficient for the determination of three kinds of racemes of male flowers attached to stems bearing leaves of *Cordaites*, as described above: *C. lingulatus*, *C. Mansfieldi*, and *C. costatus*, with the fruits also of the last two species, found in their normal position, attached to their supports. The mode of inflorescence of this order of plants is thus clearly recognized from American specimens.

But generally the fruits and racemes of flowers of *Cordaites* are found isolated or in fragments, and though their relation to stem bearing leaves is unknown for the present, it is advisable to name and describe them.

It is for fragments of this kind that I have preserved here the names proposed by the French author, not as generic, but as convenient appellations, substituted to the more general and ancient name of *Antholithes*.

CORDAIANTHUS (*gemmifer*), *Pl. LXXVI, Figs. 5–6b.*

(Expl. of the Plates.)

Grd'Eury, Fl., foss. p. 228. Pl. XXVI, f. 4-7.

Buds or gemmules sessile, composed of imbricated scales, often attached to the axils of a linear bract.

CORDAIANTHUS OVATUS, *Sp. nov., Pl. LXXVI, Figs. 5, 5a.*

Gemmules ovate, sessile in the axils of a linear bract; scales closely imbricate, ovate-lanceolate, acute.

These gemmules vary in size from six to eight millimeters, being generally longer than broad with a conical apex, but also rounded or obovate. The number of scales is proportionate to their age, and the scales are either closely appressed in their whole length or half open.

In the analysis of a specimen from Illinois which I described under the name of *Schutzia bracteata*, Geol. Rept. of Ill., IV, p. 427, Pl. XXI, f. 6–9, I found, under the scales, a yellowish transparent membrane, formed of elongated equilateral small meshes, inclosing or supporting very small granules of opaque brown matter. These granules, scarcely the hundredth part of a millimeter in diameter, of an irregular polygonal or round shape, were agglomerated together, separating with difficulty. From their size, the irregularity of their shape and their mode of agglomeration, I considered these corpuscles as pollinic grains, evidently not spores. I have not seen with them any filiform remains or fragments which might be considered as stamens.

Grand'Eury has seen the same kind of organism, which he describes, l. c., p. 229, and finds in their conformation an affinity to the pollinic vesicles attached under the bracts of Conifers. They are represented in his flora, Pl. XXVI, f. 2.*

The specimen from Illinois probably represents a different species. But it is not possible to find specific evidence from its outside characters, as except the gemmules cut for analysis, most of the others are deteriorated by maceration, some of them resembling small oval nutlets transformed into charcoal.

Habitat—This species is abundant at Cannelton.

CORDAIANTHUS DICHOTOMUS, *Sp., nov., Pl. LXXVI, Fig. 6–6b.*

Branches thick, dichotomous; gemmules sessile in the axils of linear bracts, crowded, narrowly oval; scales lanceolate, acute, few.

The essential character of this species is the dichotomous division of the branches which seems to have been derived from a fasciculate rather than from a simple axis. No species of *Cordaianthus* with a ramification of that kind has been described by the authors. All those figured by Grand'Eury have simple racemes. The gemmules appear to be in different stages of maturation; some with imbricated scales are naked, the bracts being already detached; others are like unopened buds in the axils of the bracts.

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* Renault has described and admirably figured transverse and longitudinal sections of flowering buds of *Cordaites*, exposing stamens, anthers, grains of pollen either free or taken from an unopened anther, or contained in the pollinic canal. Arch. du Mus., l. c., Pl. XVII. He finds the inflorescence analogous to that of the *Cycadeæ*.

Besides the ramification, this species differs from the former by narrower longer scales. The branches are marked by transverse lines, like scars of detached tubercles and, upon some parts of the branches, the gemmules are evidently crowded in spiral order.

Habitat—Clinton, Mo., Dr. J. H. Britts.

Of the *Cordaianthus* (*gemmifer*), described and figured by Grd'Ey, l. c.: *C. glomeratus*, *C. foliosus*, *C. gracilis* and *C. circumdatus*, none are in close relation to those considered above.

CORDAIANTHUS, (*baccifer.*)

Racemes bearing, at the axils of foliaceous bracts, small rudimental or immature ovules, either obtuse or pointed.

The ovules are solitary not aggregate, with an outside solid envelope. Two species of these have already been described, one with *Cordaites grandifolius*, as probably referable to this species, the other with *C. lingulatus*, in branches attached to a stem bearing leaves.

These fructifications are very rare in our coal measures. Under the name of *Antholithes*, and being probably a branch in a more advanced stage of maturation of *Antholithes Pitcairniæ*, Ll. & Hutt., Dr. Newberry, (Geol. Rept. of Ohio, I, Pl. XLI, f. 2), has figured a raceme with a thick, apparently cylindrical axis, three millimeters in diameter, bearing opposite, exactly ovate-obtuse ovules, six millimeters long, four wide, in the axils of short lanceolate acute foliaceous bracts. No description is given of this fragment. It is related to *C. Sub-Germarianus*, Grd'Ey, Fl. carb., p. 232, Pl. XXVI, f. 10, which has the ovules close, alternate, and the bracts longer and narrower. Another specimen, also figured by Dr. Newberry, same plate, f. 4, represents distant, nearly round, abruptly pointed nutlets, one centimeter long and nearly as broad, attached without bracts and sessile to two fragments of striate stems, one centimeter in diameter. These ovules are alternate, apparently bordered by a flat margin, like the fruits generally described under the generic name of *Cardiocarpus*. The nutlets are similar to *Cordaicarpus minor*, of the same author, Atl., Pl. LXXXV, f. 38.

A specimen from Cannelton, in the museum of Princeton College, may be referable to this group. It represents a flattened stem about two millimeters in diameter, of the same character as the stem of *Cordaicarpus ovatus*. The simple axis bears alternate or opposite nutlets inclined upward, the lower ones naked or deprived of bracts, the upper ones with short acute bractlets. The ovules, three millimeters long, half as broad, appear double or enclosed two together and appressed against each other into a membranaceous involucre, as seen when the fruit is detached or when the top of the involucre is destroyed. Some of the round involucres are evidently empty or mere bags; this is the case with the lowest upon the raceme. The small seeds are obovate, attached to the support by the acuminate base; they do not appear as surrounded by a membranaceous border as in *Cordaicarpus*.

Under the name of *Botryoconus*, Grand'Eury has remarked and described as referable to the family of the Conifers, seeds which, if not of the same order, have an analogy to those of this specimen. He has seen them enclosed in scaly buds forming ears, which he considers as far different from those of *Cordaites*. The type of this new genus is *Antholithes Pitcairniæ*, Ll. & Hutt., II, Pl. LXXXII, f. 1 & 2; also figured by Dr. Newberry, in Geol. Rept. of Ohio, Pl. XLI, f. 1, 3. The last figure is separated under the name of *Antholithes priscus*, but it appears to represent the same organism as that of the English author in f. 1; that is, in a more advanced state of maturity. Grand'Eury and also Carruther have described these seeds as short, pedicelled, enclosed three or four in the middle of opposite distichous buds attached to a striate not articulate axis. These seeds are oval, acute, surrounded by a narrow flat border, often split at the top like those in Atl., Pl. LXXXV, f. 45–50, and described by some authors as *Samaropsis*. I have considered them under the old name of *Cordaicarpus*. *Antholithes Pitcairniæ* (*Botrioconus*, Grd'Ey), is not rare in the American coal measures. I have obtained some specimens of it from the coal shale of Pomroy, Ohio, always in flattened, poorly preserved fragments. Dr. Newberry has his *Antholithes* specimens from the low coal of Youngstown.

CORDAICARPUS, *Grd'Ey.*

To this generic division are referable seeds of various size and shape, hypothetically considered until now by their association to *Cordaites* as the fructifications of these plants. Of these fruits the number is considerable, but except the nutlets figured by Newberry as *Cordaicarpus*, by Dawson as *Trigonocarpum racemosum*, (very small nutlet of *Cordaianthus baccifer*), by Weiss as *Rhabdocarpus*, and later by Grand'Eury, no seeds has been observed attached to stem or branches of *Cordaites*. Except the *Rhabdocarpus* of Weiss, all the fruits above mentioned are very small and merely in an imperfect state of development.

I have described above from specimens obtained at Cannelton two *Cordaicarpus* referable to their species of *Cordaites*, by the characters of the stem, and I have figured, Pl. LXXXIII, f. 6–11, the fruits most commonly found in the shale of the Cannelton coal, where the remains of stems and leaves of *Cordaites* are most abundant. These I refer to *Cordaicarpus*. But of all the other species, *Cordaicarpus*, *Trigonocarpus*, *Carpolithes*, some of them considerd as referable to *Cordaites*, there are none, or scarcely any, at Cannelton, and until their relation is more positively established, I describe them separately under these last generic names, generally admitted by the authors.

CORDAICARPUS GUTBIERI, (*Gein.*), *Grd' Ey, Pl. LXXXIII, Figs. 8–11.*

Cordaicarpus Gutbieri, Grd'Ey, Fl. carb., p. 236, Pl. XXVI, f. 19. Gein. Verst., p. 39, Pl. XXI, f. 23-25.

Fruit oval or subcordiform, slightly truncate at one end, and pointed at the other, or broadly obtuse at both ends, narrowly margined; surface smooth, pericarp transformed into a thin coating of coaly matter.

Seeds of this character vary in size from one and a half to two and a half centimeters in transverse diameter, generally longer than broad, sometimes circular. They are abundant in the shale of Cannelton. One of the specimens seems to be attached to a branch, but the point of connection is not clear. As represented by Geinitz, l. c., these fruits are sometimes subcordate or emarginate at the base, as in his f. 25. I have not seen any of this form. They are generally exactly oval, broadly obtuse or even round, sometimes obtusely acute at one end, point of junction to a stem, as in Atl., f. 8, which corresponds in character with f. 24, of Gein., and f. 19, of Grd'Ey, l. c. The middle part of the fruit is generally somewhat inflated, as by an oval, nearly central nucleus (f. 9), often surrounded by concentrical circles.

It is on the characters of fruits of this kind, when exactly round, that the genus *Cyclocarpus*, Goepp., has been established.

Habitat—Cannelton, Pa.

CORDAICARPUS OVATUS, *Grd'Ey, Pl. LXXXIII, Fig. 1.*

Grd'Ey, Fl. carb., p. 236, Pl. XXVI, f. 20.

Fruit smaller, oval, depressed, or slightly emarginate at the point of attachment, covered with a coaly envelope, narrowly striate lengthwise.

The specimen represents two seeds upon a narrow cylindrical flexuous peduncle two millimeters in diameter, branching in the middle, so that one of the fruits is lateral, curved downward and short pedicelled, while the other is terminal on a longer subdivision of the peduncle. These seeds measure sixteen millimeters in length, and thirteen in width. The cortex is thicker than in the former species, and regularly minutely striate. In Grd'Ey, f. 20, l. c., the fruit is a little narrower towards the apex, more distinctly cordate at base and the short pedicel is scaly. The difference in shape is evidently the result of compression of the nutlets, which is oblique in our specimen, and vertical in that of the French author. The ramification of the peduncle in the American specimen gives to the fruit a different aspect. No trace of a border or of a wing is seen upon it.

Habitat—Cannelton, Penn'a. Other specimens have been communicated without pedicel, showing a close analogy to the former species.

CORDAICARPUS APICULATUS, *Sp. nov.*, *Pl. LXXXIII, Figs. 6, 6a.**

Seeds of small size, oval, rounded at base, abruptly acuminate, bordered by a comparatively large ring, marked in the center by an oval, central ovule.

These seeds, six to ten millimeters in transverse diameter, ten to eighteen millimeters long, are distantly related to *C. congruens*, Grd'Ey, l. c., Pl. XXVI, f. 21, and compare well enough by their shape and size with *Rhabdocarpus lineatus*, Goepp. and Berg., De. fruct., Pl. I, f. 15 & 16, figured from better specimens in Gein., Verst. Pl. XXI, f. 19–20. They might be referable to two species on account of their different size. But it is now certain that the small ovules, which we see attached to their branches in an incipient state, are ovaries, which become with age, some of them at least, of very large size. This difference is not more remarkable than what is seen now between the ovaries and the mature seeds of a *Juglans*, or, to take a comparison nearer to the point, between the ovaries and the ripe fruit of a *Torreya* or a *Ginkgo*.

Habitat—Cannelton, Penn'a. Mr. I. F. Mansfield.

CORDAISTROBUS, *Lesqx.*

Strobile cylindrical, tapering to a blunt acumen, covered, by transversely rhomboidal scars placed in spiral, bearing narrow linear leaves, with the characters form and nervation of leaves of Cordaites.

The plant from which this genus is established might have been described as *Cycadoidea* or *Mantellia*, generic divisions established for the description of stems of *Cyca-*

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*These three species are given, in the explanation of the plates, as *Cordaicarpus Gutbieri.*

deæ, which are mostly globular, or conical obtuse, or nest-form, all referable to a more recent formation, the Permian. As the leaves are of a different character, as also the reference of this cone to the *Cycadeæ* is not positively ascertained, it is more rational, considering the characters of the leaves, to describe it in a separate genus, indicating its relation to *Cordaites*.

CORDAISTROBUS GRAND'EURYI, *Lesqx.*, *Pl. LXXXII, Figs. 3, 4a.*

Lesqx., Proc. Amer. Phil. Soc., 1878, p. 328, Pl. LIII, f. 3.

Cone cylindrical from the base to the middle, narrowed upward and acuminate, borne upon a somewhat thick pedicel or axis equally striate in the length; scars transversely rhomboidal, inflated in the lower part, topped by diminutive leaf scars of the same shape, points of attachment of short linear obtuse leaves.

The leaves are mostly broken above, one only is preserved whole on one side; on the other side, four remain, close to each other, all evidently attached to the rhomboidal leaf scars which show the spiral disposition of the leaves. Their nervation, seen in 4*a*, is that of the *Cordaites*. The primary nerves are close, especially toward the borders, separated by one or two intermediate veins. The axis of the cone, is covered by a coaly bark, more than half a millimeter thick. It is deeply and regularly striate, the striæ being also obscurely seen along the middle of the cone, even to its point, by compression of the scars, as represented upon the figure.

This cone seems to indicate, more than any other of the organs described, the relation of *Cordaites* to the *Cycadeæ*. By the leaves it is a true *Cordaites*; by the scars and their disposition it represents a small stem or a cone of *Cycas*. It is, however, difficult to explain its true nature. It does not look like a fruiting cone, and all that is known until now of the stems of the *Cordaites* is without relation to this organism. Another specimen of the same character is cylindrical in its whole length; but the top seems to have been destroyed by maceration. The shape and distribution of the leaf-scars are quite distinct.

Habitat—Cannelton. Mr. I. F. Mansfield.

DICRANOPHYLLUM, *Grd' Ey.*

Stems slender, leaves narrow, linear, subcoriaceous, of various length, forking, or dividing in filaments in the upper part, marked with a few thick primary nerves and intermediate nervilles more or less immersed into the epidermis.

These leaves, as remarked by Grand'Eury, are inserted around small branches, upon tumescent small bolsters, whose disposition is in regular spiral order, with a rhomboidal shape recalling that of the scars of *Lepidodendron*, but formed by the fleshy base of laterally decurring leaves like those of Conifers. The coaly envelope of the branches is thick, the foliaceous bolsters are soon effaced upon it as if the bark had increased in thickness in contact with a ligneous increasing body, as in the dicotyledonous.

DICRANOPHYLLUM DICHOTOMUM, *Sp. nov., Pl. LXXXVII, Figs. 9, 9a, (this volume.)*

Stems slender, dichotomous; leaves erect, mostly at the top of the branches, flat, nerved and undivided at the base, forked upwards or disjoined into thin filaments fixed together or loose; stem of the same character as described for the genus.

Except the dichotomous divisions of the branches the generic description resumed from the remarks of the French author is in entire coincidence with the characters of this plant. The leaves, crowded at the top of the branches, measure at base a little more than two millimeters in diameter, their length varying from five to ten centimeters. The primary nerves, three to four, are distinct and thick near the base, with three or four intermediate veinlets, f. 9*a*, more or less immersed into the epidermis. They are soon effaced upwards, either diverging or subdivided in thin filaments in such a way that from the middle of the leaves upward the surface is either very thinly lineate with indistinct veinlets, or divided into one or more laciniæ, bundles of filaments of the veins. The stem is slender, four millimeters at the base, the branches slightly narrower, three millimeters, the leaf-scars very distinct, tumescent, of the same character as those of *Cordaites costatus*, only smaller, their base inflated and decurring forming irregular coarse striæ upon a thick cortex, which is generally, like the whole stem, transformed into hard, shining coal.

This plant has some of its characters different from those of *Cordaites*, but it is merely a form of the costate *Cordaites*, which might be separated as a genus, but which, from our specimens at least, cannot represent a different order.

Habitat—Cannelton, Penn'a. Mr. I. F. Mansfield.

DICRANOPHYLLUM DIMORPHUM, *Lesqx., Pl. LXXXIII, Figs. 1, 2, (3?).*

Proc. Am. Phil. soc., 1878, p. 329, Pl. LIV, f. 1, 2, (3?).

Stem or branches small, the largest seen not quite two centimeters wide (flattened), apparently articulate at the point of divergence of the branches and there slightly narrowed, covered with a coaly bark about half a millimeter thick; stem leaves oblique or in right angle to the branches, narrow, linear, lacinate at the top; nerves distinct under the epidermis, four or five primary ones near the base, unequally distant; intermediate veinlets indistinct, not perceivable with the glass; top leaves broader with the facies and characters of leaves of Cordaites.

The top of the stem f. 2, which is not figured, bears a reniform scar like those of *Cordaites costatus;* it is probably that of a top leaf like those of f. 1.

The stem, f. 1, seems like articulate by a depression across its whole diameter at the point of attachment of the branch 1*a*. The top of this branch terminates abruptly in an obtuse apex to which is attached a somewhat thick leaf like that of *Cordaites*, with parallel nervation. The top of the main stem bears a tuft of three leaves of the same character, flat, linear, one centimeter broad. The two on the left side are somewhat thick, their veins are immersed into the epidermis; that on the right side is represented by the impression of its lower surface, with primary nerves distinct to the eye, three in one millimeter, with two or three distinct intermediate veinlets. The other leaves attached along the stem are *Dicranophylloid*, with the nerves rendered more or less obsolete by the thick epidermis. They are of the same character as those of f. 2, which appear to be borne upon a tumescent base. We have here, therefore, in the abrupt termination of the lateral branch, f. 1, and the large leaves at the top of the main branch, the characters of *Cordaites*, while the stem leaves have evidently those of *Dicranophyllum.*

The ramifications of f. 1 confirms the observations of Grand-'Eury—that some of the branches are very long and simple; that others bear a single isolated branch, while others have them by two opposite, and even it seems sometimes many branches are placed nearly at the same level as in the Conifers. This variation explains the dichotomous ramification of the former species.

One of our specimens, f. 3, represents a small seed, oval and similar in form to the ovules which Grand'Eury has represented in the axils of the leaves of *Dicranopyhllum*, Pl. XXX, f. 3, of his flora. The seed is somewhat larger, with flattened borders and of a thick texture; at least its surface is covered by a pellicle of coal as thick as that upon the leaves of *Dycranophyllum.* Under it, or as enclosing it in its axil, is a leaf of *Dycranophyllum*, four millimeters broad, soon splitting twice and separating in three narrow branches hamulose in their curve, and dividing again in filiform laciniæ at their extremities. The character of nervation, four primary distinct nerves in one of the laciniæ, as seen where the thick epidermis is destroyed, are exactly the same as in the leaves, f. 2. Hence I believe that we have here positive evidence that these organs are referable to the genus *Dicranophyllum* as established by the celebrated French author, and also that this genus is related to the order of the *Cordaiteæ.* The ovule at the base of the leaf may be there by casual occurrence.

Habitat—Cannelton, Penn'a. Mr. I. F. Mansfield.

DESMIOPHYLLUM, *Lesqx.*

Stems slender; leaves narrow, sublinear, gradually enlarged from the base, single and sparse, or joined three or four together and fasciculate at the base; surface of stem and leaves irregularly ribbed lengthwise by prominent large bundles of nerves buried under the epidermis which is thick, irregularly granulose, by splitting of the coaly layer.

From the coincidence of characters in the surface of the leaves, I was inclined to consider this peculiar branch as referable to the *Tæniophyllæ.* It, however, greatly differs by the agglomeration at their base of some of the leaves coming out in bundles from a common button-like point of the stem which there appears irregularly articulate. Some of these leaves are separate and joined single by a semilunar base to the stem. But the base of the inferior leaves is not perfectly distinct and appears rather truncate than semi-lunar and embracing. The point of attachment of the leaves in bundles is, however, clear. Therefore, the lower leaves may have been separated from a common point and scattered along the stem, where by compression they seem joined to it. The round points showing scars of bundles of leaves are seen all along the stem and at equal distance from each other, even to the very base, and, therefore, the separate distribution of the others in the intervals seems anomalous. On this subject Prof. Heer remarks that the disposition of these leaves has an affinity to that of the leaves of *Salisburia*, which, generally attached upon short button-like branches, and then close to each other at base, or like fasciculate, are also often scattered single upon the branches.

DESMIOPHYLLUM GRACILE, *Lesqx., Pl. LXXXII, Fig. 1.*

Proc. Am. Phil. Soc., p. 333, Pl. LIII, f. 1.

Specific characters same as those of the genus.

The figure is an exact representation of the specimen as far as it can be observed. The stem, a little more than one centimeter thick and flattened, seems to have been, if not fistulose, at least soft and flexible. Its surface has the same appearance as that of the leaves, the epidermis being of the same texture, and the bundles of nerves being also indistinctly discernible by the irregular vertical ridges, or the more or less obscure and always obtuse wrinkles. The leaves appear long; none of them is preserved entire. They are sessile, two or three millimeters broad at their point of attachment to a circular scar, gradually and equally enlarging upwards to about one centimeter at the point where they are broken. To the naked eye, the leaves and stems appear smooth, rather shining, but with the glass, the surface is seen rugulose.

Habitat—Same as the former. Mr. I. F. Mansfield.

LEPIDOXYLON, *Lesqx.*

Stems or branches of large size, tapering up to a conical point; bark thin, covered with leafy scales; leaves of various size, sub-linear, narrowed or enlarged to the point of attachment, forking or dividing upward in two or more laciniæ; nervation distinct with the glass only; primary nerves parallel, about three in two millimeters, buried in the epidermis, generally inflated or half round, intermediate veinlets very thin, distinct upon the decorticated face.

LEPIDOXYLON ANOMALUM, *Lesqx., Pl. LXXXIV; LXXXIII, Fig. 5.*

Proc. Am. Phil. Soc., p. 334, Pl. LIV, f. 5; Pl. LV, f. 1–1a.
Schizopteris anomala? Brgt., Hist. d. veg. foss., p. 384, Pl. CXXXV.

Specific characters same as for the genus.

The fragment of stem figured is six centimeters broad at the base, conical at the top. The bark is a thin coating of coaly matter covered with sparse, distinct, foliaceous, oblong-lanceolate pointed or acuminate scales, marked near the base by a short inflation like a midrib.

The lower surface of the stem, where this thin bark is destroyed, shows round scars of various size, from one to two millimeters in diameter, irregularly distributed, which represent either the base of the scales or that of small leaves. Short small leaves, narrowed to the base, are attached upon the stem, mixed with the scales. On the borders, the leaves are more enlarged at base, a few only of them are narrowed, others are seemingly broken and compressed upon the stem, others still are enlarged as mere diverging and detached fragments of the stem. They vary in diameter from three to ten millimeters, divide by an anomalous forking in acute sinusses, either from near the base or from above, and are marked lengthwise by parallel equal and equally distant primary nerves and very thin intermediate veins.

I consider the species as identical with that of Brongniart described in great detail, l. c., especially from the figure of Gein., Verst., Pl. XXVI, f. 2, which has the divisions of the leaves of this species somewhat broader than figured by Brongniart. In my specimens the leaves are still broader. I must say, however, that in another specimen in my possession, which is like the top of the fig. Pl. LXXXIV, the stem, whose scars of scales are marked upon the bark in elevated round points, bears, mixed with the scales, linear leaves as narrow as those represented by Brongniart. Though there may be some doubt of the specific identity between the American and the European plants, they evidently belong to the same group and are referable to the same genus.

Specimens of *Schizopteris anomala* are very rare. After Brongniart none have been found, or at least described, but that of Geinitz. Brongniart in considering his species admits it as probably referable to Ferns. Geinitz joins it to *Aphlebia*, Presl., *Rhacophyllum*, Schp., a genus which, as seen from the species described in this flora, is a compound of mixed types whose affinity is not positively ascertained, and which Schimper considers as representing primary fronds of Ferns. From this genus this species is positively removed, not only by its peculiar stem, but by the character of its ribbon like equally nerved leaves. On the true relation of the plant to any of the present time, I can say nothing. Like *Cordaites* it has some analogy to the *Cycadeæ*, for it seems evident, from the shape and the nervation of its leaves, that it is related to the *Cordaites*.

The stem is of a peculiar character. It appears to have been rather of a soft than of a hard texture. The bark is so thin that, after erosion, some of the scales and young leaves are left attached to the lower surface of the stem, as seen in the upper part of Pl. LXXXIV. On another side, large leaves, especially seen upon my specimens, are decurring at the base along the stem, and join it by a division of their borders, or come to it in a more or less open angle of divergence without any diminution of their width and without apparent separation at their point of union, just as if they were lacineæ split from the stem. The epidermis of the leaves is also thin ; the primary nerves are half buried into it, and then appear distant as in f. 2, of Brongniart ; but under the epidermis the primary veins are less discernible, sometimes totally unobservable, the intermediate ones, very thin veinlets, covering the whole surface.

Habitat—Communicated by Dr. J. H. Britts from the Clinton coal of Missouri.

FRUITS OR SEEDS.

The number of fruits represented, Pl. LXXXV, and the diversity of their characters, may give an idea of the great variety and richness of the vegetation of the coal. And yet this plate has merely a small part of the seeds known until now from the Carboniferous, and they refer only to a class of vegetables, the Gymnosperms, scantily represented in the coal flora by leaves and stems.

The fossil seeds of the American Carboniferous are generally found flattened by compression in beds of shale, or preserved in their original shape in ferruginous clay, or in sandstone, where their whole texture is transformed into amorphous homogeneous compounds. Of course no analysis of the texture of the fruits preserved in that manner can be made. The characters considered for their classification and determination are merely taken from the outside shape of their teguments; and as these are often composed of divers superposed layers, Sarcotesta or fleshy envelope, Pericarp, Endocarp, or inner and outer Testa, easily separated from each other or partly destroyed or flattened in the process of maceration; and also as the surface of each of the layers is of a different character, the determination of these fruits is subject to a great degree of uncertainty.

In France, Grand'Eury has lately discovered in beds of conglomerate sandstone of the Upper coal measures of St. Etienne, a quantity of silicified vegetable remains, among them a large number of seeds, which have been anatomically prepared for microscopical examination by Mr. Renault, of the Museum of Paris, and determined by Prof. Brongniart. In his memoir on the subject,* the celebrated Professor recognizes seventeen genera, and twenty-four species of seeds, all from the same formation in the St. Etienne and the Giers coal basin, which occupies an intermediate place between the Middle Carboniferous of France and the Permian.

These seeds are divided into two essential groups—

1st. Seeds more or less compressed, bicarinate, composed of two symmetrical parts.

2d. Seeds divided in three, six, eight segments, radiating from a central axis, circular by horizontal cross-section.

To the first group the author refers the genera *Cardiocarpus*, *Rhabdocarpus*, *Diplotesta*, *Sarcotaxus*, *Taxospermum*, etc. To the second, *Stephanospermum*, *Trigonocarpus*, *Codonospermum*, etc.

Other subdivisions are still considered in the memoir. It is evident that with the materials we have at hand and able to consider merely, for their determination, the external character of the seeds, it would be impossible or at least confusing, to admit here the above classification. It

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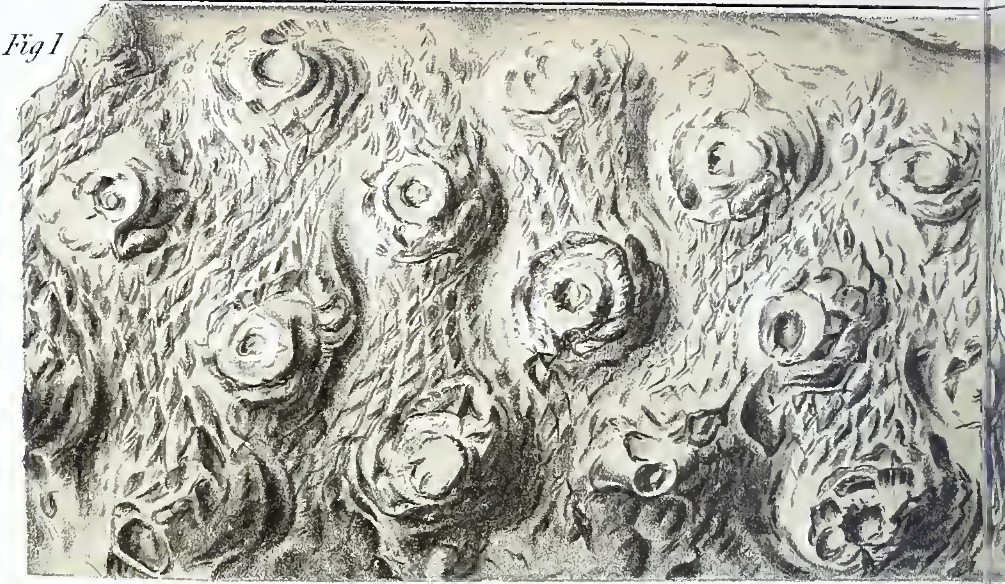
* Le graines fossils, etc. Ann. d. Sci. Nat., Bot., Ser. V, v. XX.

Fig 1



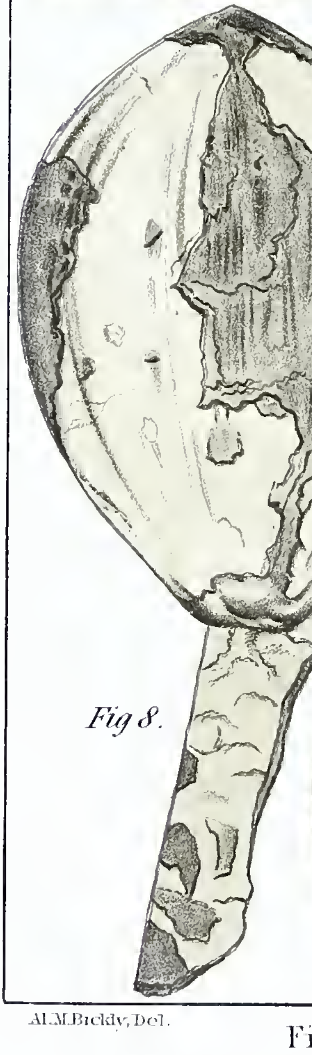
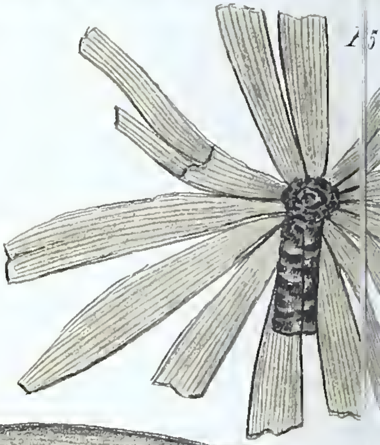


Fig 8.

Fig 7.



F 5

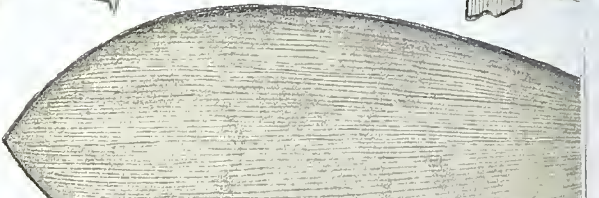
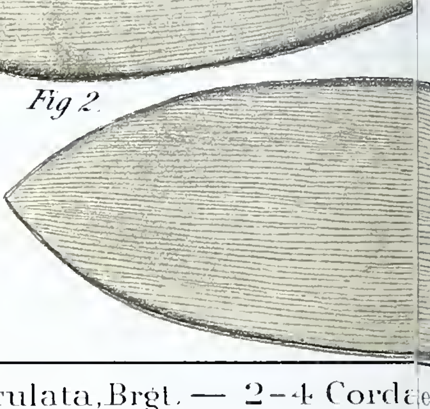


Fig 2.



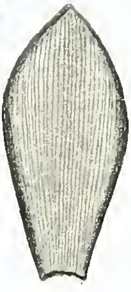
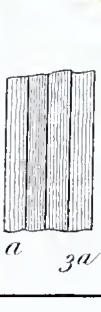


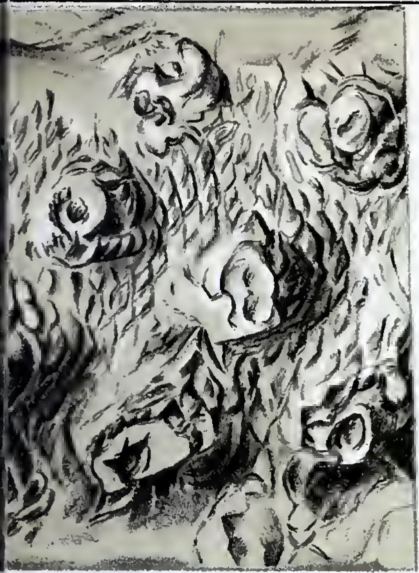
Fig 4.

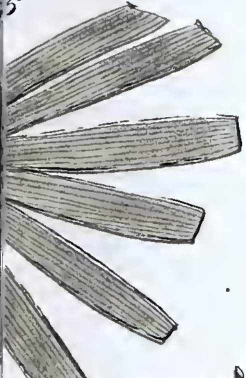


Al.M.Bickly, Del.

Fig 1. Halonia tuberculata, Brgt. — 2-4 Corda

" 8 Cordaites Mansfieldi, Lx. (fruit.) — 9, 9a





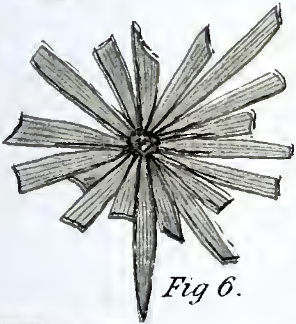


Fig 6.

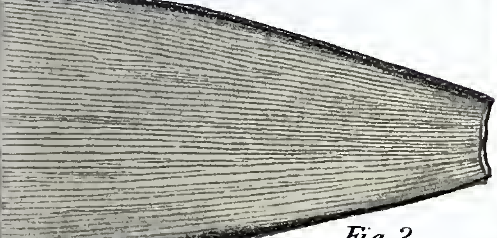


Fig 3.

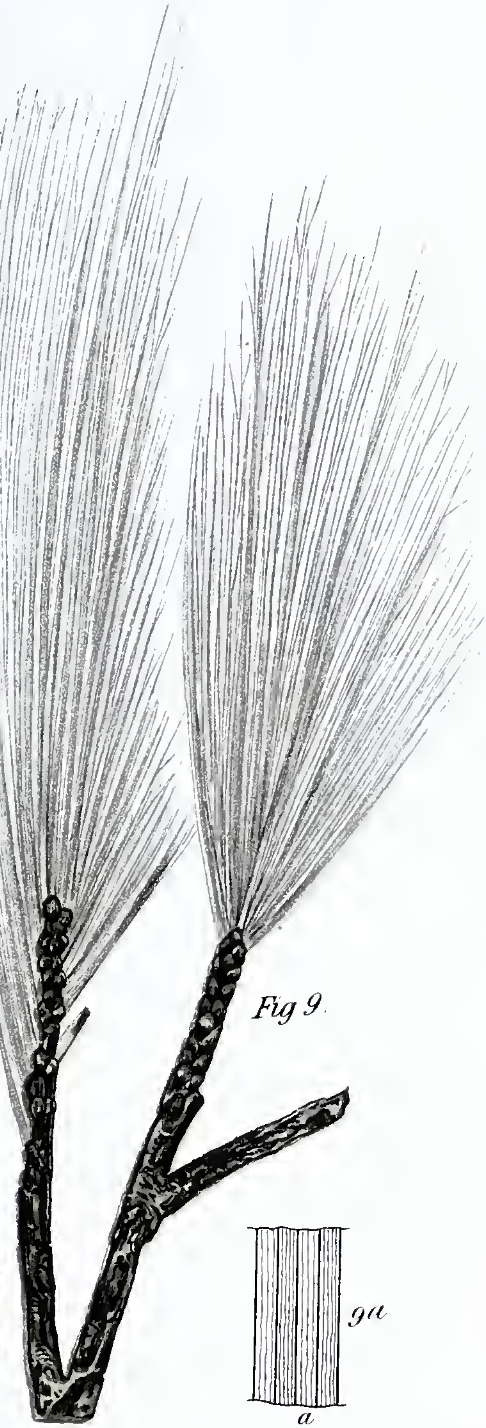


Fig 9.

es Lacoei, Lx. — 3–7 Cordaites radiatus, Lx.
cranophyllum dichotomum, Lx.

is rather advisable to follow, for the present, the traces marked by the explorators who have found the fruits in the same state of preservation as we have them, and who have described them from their outside characters.

The classification of the fruits in four generic divisions, *Cardiocarpus*, *Rhabdocarpus*, *Trigonocarpus*, *and Carpolithes*, is that of Sternberg, admitted also in the first works of Brongniart. It has been generally followed until now, and with few exceptions, which are remarked in their descriptions, all the seeds known from the American coal measures enter into this systematic arrangement.

CARDIOCARPUS, *Brgt.*

Seeds of various shape, composed of a compressed, generally cordiform or oval nucleus, surrounded by a flattened, fibrous border, or a membranaceous wing.

This definition is not that of Brongniart, who, in the Prodromus, describes the seeds of this genus as *cordiform, compressed, short pedicillate at the emarginate base, acute or acuminate, with a hard pericarp or a fleshy perisperm.* In his memoirs on silicified fossil seeds, quoted above, the author reviewing the characters of these fruits, recognizes in them, from anatomical and microscopical analysis, two different groups.

1st. *Cardiocarpus* (*Sclerotesta*)—Seeds with a very hard pericarp clearly limited on the outside.

2d. *C.* (*drapaceus*)—Seeds whose pericarp, a very dense and hard zone at its internal surface, gradually passes outside to a soft tissue composed of large transparent cells.

He however recognizes the generic affinity of these two groups, as he has observed seeds, with a compact testa homogeneous in its whole thickness, though covered by a thin stratum of transparent cellular tissues.

In the seeds described here as *Cardiocarpus*, we have also two groups or sections which probably represent different generic divisions. One for species whose nucleus is superposed to or enclosed into a kind of Samara or thin membranaceous scale, like the seeds of some Conifers.

The other for seeds bordered by a generally narrower margin, which seems more compact or composed of a fibrous tissue.

In the first section should be placed the seeds f. 38, 41, 45,–51, of Atl., Pl. LXXXV, under the name of *Samaropsis*, Goepp., a genus admitted by Weiss, Dawson, Grand-'Eury, etc. But if we consider the transitional forms between the seeds quoted above and those with narrow compact borders, we find f. 32, 39, 43, and a number of others not figured, which, evidently alate, partake of the characters of *Samaropsis*, though the borders are not quite as broad, and apparently rather fibrous than membranaceous. In these, the nucleus is certainly of a more compact texture than the borders, generally convex, perfectly distinct in outline as in the species of *Samaropsis*. Preserving, therefore, the genus in its integrity, I have separated it in two groups, according to the differences remarked above.

§ *1. Species with flat membranaceous margins or wings.*

CARDIOCARPUS SAMARÆFORMIS, *Newby.*

Ann. of Sci. of Clevel., 1853, 1, p. 152, f. 1.
Geol. Rept. of Ohio, Paleont., I, p. 375, Pl. XLIII, f. 11, 11a.

Nucleus round-cordate; base marked with the cicatrice of the point of attachment; wings emerging from near the base, gradually enlarging upwards to above the middle, rounded at the apex far above the nucleus, the inside borders inclining towards the top of the fruit where they are joined.

This species is the most remarkable of the genus. The nucleus is nearly round, two centimeters in diameter both ways, slightly striate; the wings, coming out from near the inflated point of attachment, are oval, oblique to the nut, three and a half centimeters long, nearly two centimeters broad in the middle with the inside border joined at the apex of the nucleus, appearing like two open wings of the fruit.

Habitat—Shale over coal No. 1 of the Ohio section, Talmadge, Ohio.

CARDIOCARPUS NEWBERRYI, *Andrews.*

Geol. Rept. of Ohio, Paleont., II, p. 425, Pl. XLVI, f. 2.

Nucleus somewhat heart-shaped, pointed at top, obtuse at the base; lower part distinctly punctate; wings large, broader on the sides, rounded at top and joining at the apex of the nucleus, split or emarginate at base, horizontally striate.

This description is made from the figure. The author says that the nut is covered with a thin epidermal coating, which, when removed, shows underneath the smooth body of a nut or seed, with vertical striæ toward the apex. This epidermis is covered with irregularly placed dots. The width of the whole, both nucleus and wings, is about four centimeters; that of the nucleus seventeen millimeters, the wings on the sides being twelve millimeters broad, narrowed to four at the base where they are split or divided as to a point of attachment of the nucleus to the stem.

This seed is unlike the many forms figured by Dr. Newberry. It resembles in its wings *C. Bayleyi*, Daws., from the Devonian of New Brunswick; but the nucleus is wider and more acuminate at the apex.

Habitat—Shale in the sub-conglomerate Waverly sandstone, Perry county, Ohio, with *Megalopteris*, etc.

CARDIOCARPUS INGENS, *Lesqx., Pl. LXXXV, Figs. 34, 35.*

Geol. Rept. of Arks., II, p. 311, Pl. 4, f. 4, 4a. Schp., Paleont. Veget., II, p. 223.

Nucleus cordiform, narrowed at the apex into a micropyle passing up to the sinus of the wing; wing broad, following the outlines of the ovule, somewhat larger toward the apex, where it is deeply cut into a narrow sinus.

The nucleus is two to two and a half centimeters broad, and about two centimeters in length; the wings, five millimeters broad in the middle, narrow at the emarginate base point of attachment, are gradually broader up to the acuminate apex, where the parallel borders are joined in a narrow obtuse sinus descending to near the top of the nucleus or to the upper end of the micropyle.

Habitat—Male's coal bed, sub-conglomerate, Arkansas.

CARDIOCARPUS AFFINIS, *Lesqx., Pl. LXXXV, Fig. 39.*

Lesqx., Geol. Rept. of Arks., II, p. 311, Pl. IV, f. 5. Schp., Paleont. Veget., II, p. 224.

Seed much smaller than those of the former species, broadly ovate-cordate, rapidly acuminate, marked at the base by a tumescent large dot like a chalaza, surrounded by a narrow ring.

The nucleus is one centimeter in diameter both ways, rounded at the lower part, joined to a tumescent mamilla from which appear to originate three fasciles of vessels, the middle straight up, the lateral ones diverging, following the borders and effaced in the middle of the seed. Under the apex, the nucleus bears two diverging appendages like the base of a tubular micropyle. The margin, a little more than one millimeter broad, follows the outline of the nucleus. As the top is broken, it is not possible to see if it is split, emarginate or connate. The details of the internal structure of the fruit are nearly as clearly exposed by the splitting of the seed as it would be if its compound was silicified.

Habitat—Same locality; found upon the same piece of shale as the former.

CARDIOCARPUS ANNULATUS, *Newby., Pl. LXXXV, Figs. 36, 37.*

Newby., Ann. of Sci. of Clevel., l. c., p. 152, f. 2. Geol. Rept. of Ohio, Paleont., I, p. 374, Pl. XLIII, f. 8, 8 a.

Nucleus heart shaped or short ovoid-acuminate, faintly striate, marked at base by the cicatrice of the pedicel, surrounded by an annular border slightly emarginate at the summit.

The nucleus is fourteen to fifteen millimeters in diameter, subtruncate at base, rounded up to a short acumen; the wing, five millimeters broad, slightly narrower in the lower part, follows the outlines of the nucleus and is cut at the top into a short obtuse or nearly round sinus.

Habitat—Shale over coal No. 1, Youngstown, Ohio.

CARDIOCARPUS PACHYTESTA, *sp. nov.*

Seeds of medium size, nucleus subcordate or round, subtruncate at base, rounded up to a short acumen base of the tube of a micropyle; borders flattened like wings, prolonged upward and connivent to the orifice of the tube, and also prolonged downward to the point of attachment.

The nucleus varies, on different specimens examined, from fifteen to eighteen millimeters long and from eleven to thirteen millimeters broad; the margin, either a flattened testa or a wing is five millimeters on the sides, prolonged upward to eight millimeters above the apex of the nucleus where both sides are curved down and connivent, leaving at the top a short angular space between them, like the opening or enlarging of a micropyle. The wing is also prolonged to eight millimeters below the base of the nucleus, lanceolate-acuminate to the point of attachment by an inside curve of the borders.

This species has the characters described by Brongniart as illustrative of his genus *Pachytesta*, Ann. d. sci. l. c., p. 16, Pl. XXII, f. 4. From the description, the testa surrounding the seeds is entirely compact, probably very hard, often broken by compression. In the specimen I have examined, the margin is quite flat like the nucleus, of an apparently fibrous texture, but not broken. It is continuous or like a wing bordering the nucleus all around.

Habitat—This species is represented by six specimens in the collection of Mr. R. D. Lacoe, from the sub-conglomerate ledge of Pittston, Pa.

CARDIOCARPUS (PTILOCARPUS) BICORNUTUS, *Lesqx., Pl. LXXXV, Figs. 51, 51a.*

Lesqx., Geol. Rept. of Ill., IV, p. 493.

Seeds small, alate; nucleus ovate-lanceolate, acuminate, bordered by a large margin prolonged and narrowed down-

ward into a long pedicel, continuous to the apex of the nucleus, where the two extremities are diverging outward and acuminate or horn shaped.

The nucleus is small, flattened though convex on the surface, seven millimeters long, three millimeters broad near the rounded base, hence gradually tapering up into a sharp acumen. The wings are formed of a thin somewhat membranaceous substance, from which the nucleus is easily separated. Aside of the seed, the margin which follows its borders is two millimeters broad, prolonged downward by a curve into a narrow pedicel, whose end or point of attachment is seven millimeters below the base of the nucleus. From their point of union at the apex of the ovules, the wings take an outward opposite direction and are rapidly acuminate.

These seeds have a marked affinity to those of some Conifers, *Abieteæ* or *Taxodiaceæ*, like *Taxodium distichum*, for example, which has the scales of its seeds with one sided horn, and prolonged below the base of the nucleus though far less than in this fossil seed. *Sciadopitys verticillata*, Sieb. and Zucc., also, of Japan, has seeds with the nucleus placed in the middle of a scale prolonged downward about half a centimeter, with the borders joining at or above the apex of the ovules and there obtuse. The scale is, therefore, emarginate as in the fossil species, but the borders are obtuse at the apex instead of acuminate.

As the close relation of these seeds with those of some Conifers seemed to authorize their separation under a different general division, I proposed for it the name of *Ptilocarpus*, Geol. Rept. of Ill., l. c. But as many other seeds, *Samaropsis* especially, which were then unknown to me, show a great analogy of characters with this one, its separation is not more appropriate than that of a number of others, as seen in the general remarks on the genus.

Habitat—Found by Rev. H. Herzer, in the shale above the coal of Coshocton, Ohio, and kindly communicated in a number of specimens.

CARDIOCARPUS LATUS, *Newby.*

Ann. of Sci., l. c , p. 153, f. 3. Geol. Rept. of Ohio, Paleont., 1, p. 372, Pl. XLIII, f. 3.

Nucleus broadly ovate, acute, marked with a cicatrice at the subtruncate base, smooth ; borders of the same shape, continuous, emarginate and narrower at base.

The seed has the same form as that of Atl., Pl. LXXXV, f. 38, being much larger and more sharply acuminate. The nucleus is fourteen millimeters both ways ; the margin, three millimeters broad in the middle of the fruit, enlarges to five millimeters at its acuminate conjoined apex.

I refer to this species a fine specimen No. 344 of the Mansfield collection. It differs in nothing but in the obtuse, not acuminate top of the margin.

Habitat—Roof of coal No. 1, Cuyahoga Falls, Ohio ; Cannelton, Penn'a.

CARDIOCARPUS MINUS, *Newby., Pl. LXXXV, Fig. 38.*

Newby., Ann. of Sci., l. c., p. 153, f. 4. Geol. Rept. of Ohio, Paleont., 1, p. 372, Pl. XLIII, f. 4.

Nucleus smaller but of the same shape as in the former species, with a basilar cicatrice and traversed by an elevated line passing through to the apex of the margin.

The nucleus is six millimeters in diameter, eleven millimeters long ; the margin which surrounds it is less than one millimeter broad at the rounded base, three millimeters at the obtusely pointed apex.

Habitat—Bituminous shale below coal 1, Cuyahoga Falls, Ohio.

CARDIOCARPUS ELONGATUS, *Newby., Pl. LXXXV, f. 41.*

Newby., Ann. of sci., l. c., p. 153, f. 6. Geol. Rept. of Ohio, Paleont., 1, p. 373, Pl. XLIII, f. 5.

Seeds small, nucleus ovoia, acuminate, surrounded by a margin which is very narrow at the base, much prolonged beyond the apex of the nucleus, obtuse at the top.

The nucleus is five millimeters in diameter, one centimeter long, narrowed above into a tubular prolongation of the micropyle traversing the margin to the apex. At the base of the nucleus, the margin is extremely narrow, appearing joined to the nucleus as seen in the figure copied from the author.

But for the tubular prolongation of the micropyle, this fruit would be comparable to the winged seeds of *Albertia.*

There are in the collections of Mr. Lacoe a number of specimens with the characters of this species. I refer them to it, though they differ by the marginal border continuous and as large at the base as on the sides, only abruptly emarginate to the point of attachment. The margin ascends high above the apex of the nucleus, where it measures five millimeters in width, and there abruptly curves to the apex of the tubular prolongation. It is only one millimeter on the sides.

Habitat—Shale of the coal No. 1, Youngstown, Ohio. Sub-conglomerate ledge of Pittston, Penn'a.

CARDIOCARPUS (SAMAROPSIS) ZONULATUS, *sp. nov., Pl. LXXXV, Figs. 44, 45.*

Seeds small, nucleus ovate, acuminate; margin narrower at the base, enlarging up to the apex of the nucleus and there emarginate.

The nucleus is joined by one or two concentrical circles appearing as double envelopes of a small internal ovule of the same shape. In its whole, the seed is from five to seven millimeters in diameter, the margin, one millimeter, or a little broader in the upper part. The apex of the nucleus passes up into a thin tube of a micropyle, which ascends to the head curve of the borders.

Habitat—Sub-conglomerate ledge of Pittston, Mr. R. D. Lacoe.

CARDIOCARPUS (SAMAROPSIS) LATE-ALATUS, *sp. nov., Pl. LXXXV, Figs. 46, 47.*

Ovule smaller, broadly margined, borders conjoining at the apex.

The nucleus is cordiform, abruptly pointed, four millimeters in diameter both ways, continued in a distinct line or micropylar tube upward to the apex where the margins are confluent. The borders, three millimeters broad at the base, four and an half at the top, follow the outlines of the nucleus.

Habitat—With the former.

CARDIOCARPUS (SAMAROPSIS) SIMPLEX, *sp. nov., Pl. LXXXV, f. 49, 50.*

Seeds small, round or broadly oval, nucleus ovate, obtuse or emarginate at base, border comparatively broad, emarginate at the apex.

The species resembles *C. zonulatus*, but differs by the surface quite smooth, the nucleus distinct, without any concentrical zone, ovate, rather obtuse at the top, obscurely marked there with a very small micropyle. The nucleus is three to five millimeters broad and four to six millimeters long. In f. 50, the micropylar tube is indicated by a narrow line between the inside border of the margin which has the same diameter three and a half millimeters all around the nucleus.

Perhaps these three forms, separated as species, represent the same, though the differences appear evident. It will be only possible to judge the variability of these seeds when they are found in connection with their supports, probably enclosed many together in some involucral scales.

Habitat—With the two former species, Mr. R. D. Lacoe.

CARDIOCARPUS ORBICULARIS, *Newby., Pl. LXXXV, Fig. 40.*

Newby., Ann. of Sci., l. c., p. 153, f. 5. Geol. Rept. of Ohio, Paleont., I, p. 374, Pl. XLIII, f. 10.

Seed small, nucleus orbicular, smooth, with a minute scar at base, entirely surrounded by a narrow border.

From the description of the author, the seed is figured overturned, as the small cicatrice is placed at the top where the nucleus is slightly emarginate. It is six millimeters in diameter both ways, the continuous margin only one millimeter.

Habitat—Shale over coal No. 1, Cuyahoga Falls, Ohio.

§ 2. *Species with narrow compact margins.*

CARDIOCARPUS DIMINUTIVUS, *sp. nov., Pl. LXXXV, f. 48.*

Seed very small, ovoid-acute, margin continuous, equal all around.

This small fruit is only two and a half millimeters long and one and a half broad, inflated or convex on the smooth surface. The very small lenticular nucleus is often seen separate or deprived of its borders, its convex, polished, apparently hard testa raising over the surface of the shale. It thus resembles *Rhabdocarpus minutus*, Lesqx., whose testa is, however, ribbed lengthwise.

Habitat—Sub-conglomerate ledge of Pittston, Pa.; Mr. R. D. Lacoe.

CARDIOCARPUS FASCICULATUS, *Sp. nov., Pl. LXXXV, Figs. 30, 30a.*

Seeds of various size, ovate, acuminate, margined; nucleus slightly lineate lengthwise, margin conforming to the nucleus, continuous, or slightly emarginate and bicuspidate at the apex.

These fruits are evidently in racemes, as seen by their position, placed as they are in number and in corresponding direction to branches, with which, however, I have never distinctly seen the point of connection. F. 30*a* represents the fruit enlarged. The nucleus is seven millimeters long, scarcely half as broad, smooth, convex, or inflated, marked with some obscure longitudinal lines, bordered with an equal sized flat margin one millimeter broad, notched at the top or broken. It is not possible to see if the notch is casual or natural. The characters of this seed refer it as well to *Cardiocarpus* as to *Rhabdocarpus.*

Habitat—Sub-conglomerate ledge of Pittston; Mr. R. D. Lacoe.

CARDIOCARPUS APICULATUS, *Goepp. & Berger.*

De fruct., p. 23, Pl. II, f. 32.

Seed small, nucleus oval, traversed from the base by a medial line passing up to the emarginate or mammillate apex of the borders.

The seed is represented overturned. The nucleus is exactly oval, four millimeters broad, five long, the margin equal, emerging from the basilar point of attachment, a little enlarged to the emarginate apex, the whole seed being ovate. The authors represent the apex as bicuspidate by the enlarging or dividing of the medial costa. In the specimens examined, some have the costa nearly effaced, and the bicuspidate apex is seen as formed by the acute border of the margin cut near the point or emarginate, as it is generally the case in species of this genus. Except for that medial costa the species is a *Samaropsis*.

Habitat—Same as the former.

CARDIOCARPUS? MAMILLATUS, *Lesqx., Pl. LXXXV, Figs. 32–33a.*

Rhabdocarpus mamillatus, Lesqx., Geol. Rept. of Ill., IV, p. 461, Pl. XXXI, f. 12–15.

Seed small; nucleus oval, mammillate at the base (or apex), regularly and deeply striate, surrounded by a flat margin or flattened testa.

From the specimen f. 33, the species should be referable to a *Rhabdocarpus*, but specimen f. 32, which I consider as a larger form of the same, has a flattened margin which, however, may be merely the fragment of a pericarp imbedded into the stone. The nucleus is oval or nearly round, ten to twelve millimeters long, seven to ten millimeters broad, deeply regularly striate lengthwise, with a small protruding mamilla in the middle of a small round smooth surface at its top.

I should have preserved the original name of this species and described it as a *Rhabdocarpus*, if I had seen only the seeds from Illinois. But the Pardee Museum, at Easton, Penn'a, has a number of very fine specimens nearly exactly round, like f. 32, some of them covered with a thin pericarp obscuring the striæ, others free of it with a margin; and in the collection of Mr. R. D. Lacoe, there is a number of oval specimens slightly larger than f. 33, but of the same oval form, all apparently referable to the same species which is intimately related to *C. lagenarius*, St., Fl. d. Vorw., I, Pl. VII, f. 16, or perhaps identical with it. This last figure shows the fruit margined, the border ascending higher than the apex of the nucleus to the orifice of the tube of the micropyle.

Habitat—Concretions of Mazon creek, the specimen f. 33; Hazleton mines, f. 32. The specimens of Mr. Lacoe are from Ontario colliery, Pittston. I am not certain that all the specimens represent one species only.

CARDIOCARPUS REGULARIS? *Sl., Pl. LXXXV, Figs. 31, 31a.*

Carpolithes regularis, St., Fl. d. Vorw., 1, Pl. VII, f. 2.
C. ellipticus, St., ibid, f. 1.

Seed small, nucleus oval, surrounded by a broad, fleshy? pericarp, regularly striate lengthwise.

The nucleus is only five millimeters long and half as broad. It is surrounded by a pericarp one millimeter thick on the side, broader toward the base, striate lengthwise, the lines being parallel on the whole seed, and covering the testa. The borders are not, therefore, margined. This seed seems to belong to a same generic division as the former, intermediate to *Cardiocarpus* and *Rhabdocarpus*.

Carpolithes regularis, St., resembles this fruit by its outline; but the nucleus is not marked upon it. I believe, however, that some of the seed described above represents the same species; for I have on a same plate of shale from Cannelton a large number of seeds of the same general character, with or without a border, all narrowly striate when seen with the glass, some with an oval, convex nucleus, others quite flat; they average five millimeters broad, seven long, and may be referable to both *C. regularis* and *C. ellipticus*, St.

Habitat—Cannelton, Penn'a. Mr. I. F. Mansfield.

CARDIOCARPUS CONGRUENS, *Grd' Ey.*

Fl. Carb., p. 236, Pl. XXVI, f. 21.

Seeds small, cordiform, more or less inflated, smooth, without margin.

Seeds of this kind somewhat varied in shape between broadly ovate-obtuse, and cordate-acute, four to eight millimeters in diameter both ways, are not rare upon the shale of the sub-conglomerate ledge of Pittston. I have seen them also on specimens from Cannelton. They resemble detached ovules, like the central parts of f. 46, 49—even 48 and 50, and may represent different species.

Habitat—Cannelton coal; Pittston, sub-conglomerate ledge.

CARDIOCARPUS MARGINATUS, (*Artis*), *Gein.*

Verst., p. 40, Pl. XXII, f. 24-27.

Carpolithes marginatus, Artis, Antedil. Phytol, Pl. XXII, f. B.

Fruit broadly oval or circular, surrounded by a narrow margin prolonged downward like a small pedicel.

These fruits, twenty to thirty millimeters in diameter, are surrounded by a border one to two millimeters, continuous, and of the same width, only prolonged abruptly downward into a short pedicel two to three millimeters long. The substance of the fruit and of the border is hard, compact; for though flattened, the borders are often broken transversely and the cauda generally destroyed. These alterations render the identification difficult.

Habitat—Seen in many specimens, all upon a piece of shale from Trevorton, Penn'a, low coal.

CARDIOCARPUS BICUSPIDATUS, *St., Pl. LXXXV, Figs. 42, 43.*

Carpolithes bicuspidatus, St., Fl. d. Vorw., 1, Pl. VII, f. 8. Lesqx., Geol. of Penn'a., 1858, p. 877.

Cardiocarpus bicuspidatus, Newby., Geol. Rept. of Ohio., Paleont., II, p., 373, Pl. XLIII, f. 9, 9a.

Seeds of medium size, broadly cordiform, abruptly acuminate, borders narrow, continuous, prolonged downward under the base of the nucleus into a short pedicel.

This species especially differs from the former by its smaller size and the cordiform shape of the nucleus, which generally abruptly acuminate or cuspidate, varies in diameter from one to one and a half centimeters and has an equal margin one and a half to two millimeters broad. As in the former species the downward prolongation of the border into a pedicel is rarely observable but the nucleus and its borders, as in f. 42, are not rare. I have, however, not seen any specimen like 43, which seems to represent a different species. It is copied like f. 42 from Dr. Newberry, l. c. This species is closely allied to *C. Gutbieri*, Gein., and has been identified with it by Gutbier.

Habitat—Upper coal strata of Penn'a, Salem vein etc. Roof shale of coal No. 1, Cuyahoga Falls, Ohio; Dr. Newberry.

RHABDOCARPUS. *Goepp. & Berger.*

Seeds ovate or oblong, costate or striate, acute or acuminate surrounded by a putamen sometimes deficient.

Prof. Brongniart remarks, Ann. d. Sci., l. c., p. 13, that the Genus *Rhabdocarpus* is one already established by Goeppert from mere surface impressions and characterized by the presence of striæ or longitudinal furrows upon their outer testa; but that this character is very uncertain. According to the French author, the genus may be characterized by the remarkable texture of its testa, of which the internal layer (endotesta) is clearly limited and composed of a dense and compact cellular tissue, while the outside layer (sarcotesta) is remarkable by the presence in its cellular tissue of numerous solid fibres which pass obliquely from the base to the summit, constituting a carnose and fibrous envelope which is prolonged above the nucleus, as much towards the summit, as towards the base. In the interior of the endotesta one sees the chalaza, and opposite or to the upper end, the micropyle and also the erected nucelle with its conical top, without appearance of any pollinic cavity. The nucelle seems united to the testa in its lower part, in the same manner as in some Conifers. The chalaza receives a central vascular fascile from which two others are derived and continuous outside of the carena in its whole length. Brongniart adds that two or three species of *Rhabdocarpus* have been observed in a silicified state, but that it is difficult to define their characters and to indicate their relation to the species already remarked in other localities.

The last remark of Prof. Brongniart shows, as I have said already for species of *Cardiocarpus*, that the analyses of silicified specimens are of no advantage for the definition and determination of specimens flattened and preserved upon shale, or known only by impressions of their outside surface. It may be remarked also that we may recognize, from impressions of the specimens preserved in the coal shale, characters which have not been observed upon silicified specimens, as, for example, the pedicel of *R. Jacksonianus.*

Some of the fruits described here in this genus have a pericarp of apparently fibrous texture, smooth or without ribs, but, from what is seen of analogous forms, the inside or endotesta is evidently striate. A few, whose endotesta is not known, are, therefore, hypothetically referred to this genus.

RHABDOCARPUS INSIGNIS, *sp. nov., Pl. LXXXV, Fig. 26.*

Seeds large, broadly ovate, apiculate, obscurely marked at base by a broad cicatrice point of attachment, indistinctly striate by equidistant lines and irregularly closely, deeply lineate or wrinkled lengthwise.

This fine fruit with outside envelope finely preserved, is flattened to one and a half centimeters in thickness in the middle, convex or lenticular, with obtuse borders. It is nearly exactly oval, six centimeters broad in the middle, the top marked with a short acute point, or mucronate. Its surface is polished, though doubly striate as described above.

Habitat—Pittston, Penn'a, Seneca mine, coal seam F, Mr. R D. Lacoe.

RHABDOCARPUS HOWARDI, *sp. nov., Pl. LXXXV, Fig. 24.*

Fruit large, oblong, curving a little to one side, rounded *at base, narrowed at the apex to a short acumen, marked lengthwise with distant narrow elevated ribs, indistinctly minutely lineate in the intervals.*

We have here evidently the nucleus only. It is transformed into sandstone and preserved in its integrity or cylindrical in the middle. It is seven centimeters long, three and a half centimeters in diameter in the middle, where it is a little inclined on one side, rapidly, sharply acuminate, marked by eight distinct narrow ribs and irregularly striate lengthwise. The lines in the intervals of the ribs are not very distinct, apparently on account of the coarseness of the stone. This fruit may be a *Trigonocarpus.*

Habitat—Sandstone beds south of Ohio, locality unknown.

The specimen was presented to me years ago by Dr. Howard of Columbus, Ohio.

RHABDOCARPUS JACKSONIANUS, *Lesqx., Pl. LXXXV, Figs. 17–19.*

Carpolithes Jacksonensis, Lesqx., Geol. Rept. of Ill., II, p. 461, Pl. XLVI, f. 4.

C. sulcatus? St. Fl. d. Vorw., II, p. 208, Pl. X. f. 2., (from a deteriorated specimen?)

Seeds ovate-oblong; upper cortex obscurely ribbed, striate and fibrous; endotesta deeply cut lengthwise into eight to ten elevated obtuse or sharply keeled ridges, converging both at the upper rounded apex and at the truncate point of attachment of the pedicel; nucleus oblong, slightly narrowed to the emarginate apex.

The specimens represent three distinct forms of the species, in different degrees of preservation. Fig. 18 is a seed with the outside envelope transformed by maceration into a coating of fibrous coaly matter, half to one millimeter thick. The endocarp is hard, smooth, deeply cut lengthwise in obtuse or sharply keeled ridges, eight to ten, connivent at the round top and at the truncate base or point of attachment of a pedicel. The nucleus, f. 17, is small, has the same shape as f. 18, and its surface is covered also by fibrous coal. F. 19 represents a small specimen with its endocarp. The ribs are less distinctly marked and less numerous than in other specimens, one of which, the best, is five and a half centimeters long nearly two and a half centimeters broad in the middle. I have seen a number of others which I consider all referable to the same species, though generally different in shape and size, and also in the numbers and width of the ribs, according to their state of preservation. They have been or may be easily ascribed to different species.

Trignocarpus species, Newby, Geol. Rept. of Ohio, Paleont., I, Pl. XLII, f. 9, and Pl. XLIII, f. 15, which shows the ribbed endocarp, under the epicarp partly destroyed, seem to be referable to this species.

An important specimen has been lately sent for examination by Mr. Lacoe, (No. 224*a* of his collection). The nucleus with its endocarp is loose or separated from the epicarp which is two millimeters thick, as seen by the flattened borders surrounding the concave ribbed impression. This seed is attached to a pedicel a little more than one centimeter long, five millimeters in diameter at its point of connection, decreasing to two millimeters at its broken end. The flattened margin or the epicarp is prolonged downward in narrowing gradually from the base of the seed to the point where the pedicel is broken. As the pedicel is ribbed and the outer testa quite flat and smooth, the relation of these different parts is quite distinct. The pedicel is not adherent to the nucleus which does not leave at its base an impression of its connection; it is clearly a part of the outer testa or sarcocarp, from which the nucleus is entirely free.

By compression, the costæ of these seeds are often separated at the top and diverging as if cut into large teeth, like the borders of sheaths of *Equisetites* figured Atl., Pl. III, f. 15 and 16.

Habitat—Not rare. The first specimen described, Geol. Rept. of Ill., is from Murphysborough, Jackson county. Dr. Newberry's specimens are from the shale above coal of Cuyahoga Falls, Ohio, with *Whittleseya elegans*. Numerous specimens of Mr. Lacoe are from Oliphant and Pittston, Pa., Port Griffith and Butler mines.

RHABDOCARPUS MULTISTRIATUS, *Presl. Pl. LXXXV, Figs. 22, 23.*

Carpolithes multistriatus, St., Fl. d. Vorw., II, P. 208, Pl. XXXIX, f. 1, 2. Lesqx., Geol. of Penn'a, 1858, P. 877. Geol. Rept. of Ill., II, p. 460, Pl. XLVI, f. 2.

Fruit oval-oblong, rounded at base; outer testa prolonged beyond the nucleus and narrowed upward into an obtuse apex, obscurely ribbed and striate lengthwise; nucleus shorter, ovate, apiculate, distinctly equally ribbed, marked at the base by a large cicatrice point of attachment.

This species is obscure, and probably includes others described under different names. Sternberg's figures l. c. represent an oval fruit, exactly corresponding in shape and character, only slightly larger, with Atl., f. 22. In St., f. 1, the point of the seed (turned down) is prolonged and broken; the acumen is marked also f. 2, but destroyed near its base. The number of ribs is the same, and they are also equal and distinctly obtuse on the back.

The specimen figured in Geol. Rept. of Ill., l. c., is a longer and narrower fruit, which appears covered with the sarcotesta, as the striæ are less distinctly marked. It is gradually narrowed to an obtuse apex as would be that in Atl., f. 22, if the outer testa was preserved in its integrity. The size of the specimens representing this species is variable. The nucleus is from three to five centimeters long and two to three centimeters in diameter below the middle where the seeds are generally broader.

It is remarkable that this species of Presl., is not mentioned by any author except Sternberg. It has a close affinity to *Trigonocarpus Schultzianus*, Goepp. & Berg., as figured by Fiedler, Foss., Fr. 2, Pl. XXVI, f. 26.

Habitat—Not rare in the lower coal measures above the conglomerate; Shamokin, Penn'a; Pittston, Ontario colliery; Carbon hill shaft, etc. B. & C. veins; Cannelton, where it is abundant; Colchester, Ill., etc.

RHABDOCARPUS CARINATUS, *Newby.*

Geol. of Ohio, Paleont, I, p. 376, Pl. XLIV, f. 3.
R. apiculatus, Newby, ibid, p. 377, Pl. XLIV, f. 6.

Nut ovoid in outline, rounded below, somewhat acute above; surface marked by numerous longitudinal rounded ribs which become effaced near each extremity; outer testa thick apparently obscurely striate.

Nothing seems to separate this species from the former but the greater thickness of its sarcotesta which appears obscurely striate on its surface. *R. apiculatus* is evidently a decorticated specimen of the same fruit as supposed by the author.

Habitat—Shale over coal; Summit, Mahoning county, Ohio.

RHABDOCARPUS ACUMINATUS, *Newby.*

Geol. Rept. of Ohio, Paleont., I, p. 378, Pl. XLIV, f. 7.
R. costatus, Newby, ibid., p. 378, Pl. XLIV, f. 8.

Nut large, broadly ovate in outline, rounded below, acute and long pointed above; surface nearly smooth, showing faint traces of longitudinal ridges.

The author supposes that this may be the same species as *R. costatus*, with a better preserved epicarp. Both the fruits have the same size and the same characters. As in species of this genus, the outer testa is generally prolonged upward, and, therefore, longer acuminate than the endocarp.

Habitat—Shale over coal No. 1, Youngstown, Ohio.

RHABDOCARPUS LÆVIS, *Newby.*

Geol. Rept. of Ohio, Paleont., I, p. 377, Pl. XLIV, f. 5, 5a.

Nut ovoid in outline, rounded below, with the central point of the base slightly prominent, constricted but obtuse above; sides equally arched, smooth and polished; section lenticular with acute edges.

From the description, this species is related to *R. insignis*, Lesqx., from which it differs especially by its ovate shape and small size. These nuts are evidently of the same kind as those described above by the author, even probably represent the same species of seeds preserved with their sarcotesta which is generally indistinctly ribbed lengthwise. I have from Indiana two specimens of this kind, ovate in outline, same form as *R. lævis*, six centimeters long, four centimeters broad, obtuse at the upper end, one of them bearing at the top an enlarged border or inflated margin, reflexed or passing over the orifice of the seed like a crown.

Habitat—Sub-conglomerate coal, Cuyahoga Falls, Ohio. The specimen mentioned from Indiana is from an upper coal near New Harmony. It is quite flattened.

RHABDOCARPUS DANAI, *Foster*.

Ann. of Sci. of Clevel., 1, p. 129. Newby., Geol. Rep. of Ohio, Paleont., I, p. 376, Pl. XLIV, f. 4.

Nucleus oblong, compressed and finely striate, the base obtuse, the apex sharp, terminating in a point, bearing remains of an elevated line seen at the apex, and of a depressed line extending from the base nearly one half the length of the nut in the direction of the axis; nucleus surrounded by a broad corrugated margin in which are visible four or five folds parallel with the margin of the nucleus.

This fine fruit appears to have a double or at least a very thick epicarp. It may be, however, that both the endocarp and the sarcocarp, softened by maceration, have been pressed obliquely when being partly detached from the nucleus, and that the borders, then, appear enlarged by juxtaposition of two or three ribs of the two outer layers. The figure shows, at the top of the nucleus, a nucelle narrowed up to the base of the micropyle

The author remarks that the specimen is badly fractured and gives but an imperfect idea of the entire fruit.

Habitat—Shale over coal No. 3, Zanesville, O., J. W. Foster; Pittston, Penn'a, Mr. R. D. Lacoe. The specimen from Pittston is also compressed and obscure.

RHABDOCARPUS CLAVATUS? (*St.,*) *Gein., Pl. LXXXV, Figs. 14, 20.*

Gein., Verst., p. 42, Pl. XXII, f. 12–14. Lesqx., Geol. Rept. of Ill., IV, p. 461, Pl. XXXI, f. 11. Schp., Paleont. veget., II, p. 218.

Carpolithes clavatus and C. lagenarius, St., Fl. d: Vorw., 1, Pl. VII, f. 14 and 16.

Seeds oval, rounded in the lower part, narrowed below the broken or truncate apex; nucleus oval, surrounded by a broad flattened margin which ascends to the top of the tube of a distinct micropyle.

The two specimens figured represent the two species of Sternberg, l. c., with some difference, however. F. 14, comparable to Gein., l. c., f. 13 and 14, is from a specimen in nodules, cut longitudinally, exposing the nucleus transformed into pyrites. The borders are very large or double, composed of an endocarp and an exocarp apparently of the same texture, the line of division being obscure. Measured from the outside borders, the seed is seventeen millimeters broad in the middle. F. 20 is a narrower seed, only one centimeter in diameter, with the nucleus more elongated, elliptical, eighteen millimeters long, only seven millimeters in diameter, bearing at the apex, a distinct micropylar tube. The margin, smooth, as well as the nucleus, is two millimeters broad, also apparently representing both an outer and an inner testa, as seen by a line of division on the left side, while on the other side the endocarp only is partly preserved and only half as broad. This form is more intimately related to *C. lagenarius*, St., from which it merely differs by a narrower more elongated body, and also by the longer and narrower micropylar tube.

Habitat—Specimen f. 14, is from the nodules of Mazon creek. The other is from the Helena coal mines of Ala.

RHABDOCARPUS AMYGDALÆFORMIS, *Goepp. & Berg., Pl. LXXXV, Figs. 27, 28.*

Goepp. & Berg. De Fruct., p. 21, Pl. 1, f. 12, Gein., Verst., p. 42, Pl. XXII, f. 10, 11. Lesqx., Geol. of Penn'a, 1858, p. 877. Schp., Paleont. Veget., II, p. 217.

Fruit narrowly ovate, marked in the middle by a dis-

tinct elevated line; nucleus acuminate; margin broad, striate, of fibrous texture.

Of the two specimens represented here, both exposing the nucleus and the testa, f. 27 is subcordate at base, while f. 28, from a better preserved specimen, is abruptly narrowed at the base into a pedicel formed by the prolongation of the testa. Both agree with the figures of the authors, l. c. Geinitz represents the fruits smaller and narrower, but his f. 10, l. c., has the same characters as f. 27 of Atl., except that in this last the borders are abruptly rounded at the apex of the nucleus, while they are continuous and acuminate in Geinitz. Atl., f. 28, is from a specimen remarkably well preserved, exposing at its base a chalaza with a distinct medial line, ascending to the base of a micropyle, and the border of the endocarp distinctly limited.

Habitat—Low coal strata of Trevorton, Penn'a. Macdonnough Co., Ill., coal No. 3, Prof. A. H. Worthen. Pittston, Penn'a, Mr. R. D. Lacoe.

RHABDOCARPUS LATEMARGINATUS, *Schp.*, *Pl. LXXXV, Fig. 29.*

Schp., Paleont. veget., II, p. 226.

Carpolithes platimarginatus, Lesqx., Geol. Rept. of Ark., II, p. 312, Pl. IV, f. 6.

Fruit large, oval, abruptly acuminate; borders broad, flat, continuous, and equal in width.

The fruit is so much like that of f. 28, same plate, that if it cannot be considered a large form of the same species, it seems at least referable to the same generic division. The nucleus is three centimeters long, half as broad, traversed lengthwise by a distinct elevated line. The margin, three millimeters wide, is flat, smooth, as well as the nucleus. No details of organization are observable. There are only upon the surface some flakes of a thin coating of coaly matter, apparently remains of the inner face of the endotesta.

Habitat—Male's coal bank, Arkansas. Sub-carboniferous.

RHABDOCARPUS? MINUTUS, *Lesqx.*

Geol. Rept. of Ark., II, p. 313, Pl. V, f. 8, 8a.

Seed very small, oval, notched at one end, regularly minutely striate.

The seed may be merely a nucleus separated from its testa. It is only four millimeters long, two and a half broad, notched at the base, as seen f. 8*a*, enlarged, and very regularly striate lengthwise. Its relation to this genus is uncertain.

Habitat—Male's coal bank, Ark.

RHABDOCARPUS CORNUTUS, *Sp. nov., Pl. LXXXV, Fig. 15.*

Fruit oval; nucleus marginate, oval in outline, rounded at the base; outer testa prolonged at the top into two thick horn-like acute appendages.

I have for examination two specimens, one two and a half centimeters long, seventeen millimeters broad, including the borders which are of thick fibrous consistence, three to four millimeters thick; the nucleus is of the same size as that of f. 15, which has the margin destroyed. In both, the nucleus transformed into pyrite is very rough. As the imbedding nodules are split in the middle, exposing the inner part of the fruit, these horn-like appendages may be mere fragments of the pericarp enlarged crown-like at the top, with the inside of the crown exposed by the splitting.

Habitat—Nodules of Mazon creek; specimens T, 29 and 30, of the Museum Comp. Zool., Cambridge, Mass.

RHABDOCARPUS ARCUATUS, *Lesqx., Pl. LXXXV, Fig. 52.*

Geol. Rept. of Ky., (D. D. Owen), IV, p. 434.
Carpolithes rostellatus, (by erratum in Expl. of Plates.)

Fruit oblong, constricted in the middle, rounded and narrowed at the base to a pedicel, and toward the top to a prolonged acumen; outer testa thin, striate lengthwise; nucleus obscurely vertically lineate, marked by rectangular dots along the lines.

This is a remarkable fruit without analogy to any other of the coal measures. Its form is that of a peanut, *Arachis* *hypogea.* It is five centimeters long, including the beaked acumen, one centimeter in diameter in the middle where it is a little strangled, inflated and rounded upwards and downwards, narrowed at the base into a pedicel one and a half millimeters thick, and one and a half centimeters long. It is somewhat scythe-shaped, and the acuminate apex is inclined to one side. The nucleus of the same species, as seen from a specimen found at Cannelton, has the same shape as f. 52, less the pedicel and the acumen. It is narrowed into an obtuse or blunt apex, distinctly marked by sharp narrow longitudinal wrinkles, soon effaced downward; the lower part is smooth, and the base apparently broken or without a pedicel.

Habitat—I found two specimens of this fruit in a bed of soft shale of the Lower Carboniferous Measures on Burnt branch of Canney, near West Liberty, Morgan county, Kentucky, with abundant remains of *Lepidodendron* and *Eremopteris flexuosa*. The specimen from Cannelton was communicated by Mr. I. F. Mansfield.

TRIGONOCARPUS, *Brgt.*

Fruits ovoid, compressed at the base point of insertion, three or six costate, the ribs more distinct and prominent toward the base, sometimes disappearing above; apex pitted by a small round or triquetre mammillate cavity.

These fruits of various size appear to be composed of a membranaceous or fibrous testa sometimes very thick, dehiscent in valves which are often found separated from the nucleus. When these seeds are six costate, three of the ribs are stronger than the others.

These fruits have been referred sometimes to Palms, sometimes to Conifers or to *Cycadeæ*. As the Palms appear at a later period in the flora, at the end of the Cretaceous, the attribution of Trigonocarpus is probably to the *Cycadeæ*, to which the seeds have an affinity of characters.

TRIGONOCARPUS NOEGGERATHI, *Brgt., Pl. LXXXV, Fig. 1.*

Brgt., Prodr., p. 137. Ll. & Hutt., Foss. fl., III, Pl. CXCIII, B, f. 1-4; CCXXII, f. 2, 4. Goepp. & Berg., De. fruct., p. 18, Pl. I, f. 1, 2. Lesqx., *Geol. Rept. of Ill., IV, p. 460, Pl. XXXI, f. 16. Schp., Paleont. veget., II, p. 214.*

Fruit ovate with an ovate-acuminate tricostate nucleus, apparently surrounded by a double or triple thick testa.

This fruit is cut longitudinally in the middle by the splitting of a nodule of iron. The internal structure, as far as it is indicated by the different substances of the compound, is represented in the figure. The nut is five centimeters long, two and a half centimeters broad below the middle. The sarcotesta is four to six millimeters thick, of a compact smooth texture, without appearance of fibres. The endotesta transformed into iron pyrites is variable in thickness, narrow on the borders, broader at the base and the top in *b*, where it crosses the inside broad testa, prolonged upward to *c*. This inside envelope is a texture of black fibrous hard substance, separated from the ovule by a thin line or wall. The nucleus placed in the middle of the fruit is rounded at the base, gradually tapering upward and prolonged into a thread-like style which passes through the endotesta. The details are not perfectly clear; the two inner envelopes may be only one, appearing double by a difference in the mineralization of the matter.

But the sarcotesta and the small nucleus, only two centimeters long, six millimeters broad near its base, are quite distinct. The fruit, therefore, has, at least, a thick double testa, like the seeds described by Brongniart under the generic name of *Diplotesta*. It is not possible to say if this fruit is positively *T. Noeggerathi*, Brgt. In Ll. & Hutt., Pl. *CXCIII*, the figures represent nuts like the nucleus. They are of the same form but larger than in our specimen. The author remarks that he has published the same species, II, Pl. *CXLII*, *C*, and on the plate the longitudinal cross section of the fruit has the greatest analogy with that described above.

In Goepp. & Berg., also, l. c. and in Fiedler, the species is represented by nuts quite as large. I have a number of specimens of the seeds exactly similar to those figured by this last author, Foss. fr., Pl. XXI, f. 2. They are locally abundant.

Habitat—Mazon creek, communicated by Mr. Jos. Even. Sandstone at the base of the coal measures in different localities of Ill.

TRIGNOCARPUS DAWESII, *Ll. & Hutt.*, *Pl. LXXXV, Figs. 2, 3, 25.*

Ll. & Hutt., Foss. fl., III, Pl. CCXXI. Schp., Paleont. veget., II, p. 215. Carpolithes disjunctus? Lesq., Geol. of Penn'a, 1858, p. 877, Pl. XVII, f. 11.

Fruit broadly ovate or oblong, marked with three strong prominent ribs.

These fruits vary in length from four to five centimeters, and from two to two and an half in width. When covered with their sarcotesta, the ribs are scarcely seen; they are quite distinct when deprived of it, as they are generally when embedded and transformed into sandstone. F. 25 represents a specimen flattened upon shale. It shows apparently one side between the ribs. But I have, from the same locality, a number of specimens free of the testa, whereupon the nut is smooth or without any ribs like the figure of Ll. & Hutt. There is a degree of uncertainty in the identification of the specimens which I refer to this species, for *T. Noeggerathi* is represented in Fiedler, Foss. fl., Pl. XXI, XXII and XXIII, f. 10, 11, exactly like f. 2, 3, of Atl.

To the species is probably referable the nut described as *Carpolithes disjunctus*, Lesqx., l. c., a nucleus half separated from its testa.

Habitat—Base of the coal measures in conglomerate sandstone, Indiana. Shale above coal, Cannelton, Penn'a.

TRIGNOCARPUS BERTHOLLETIFORMIS, *Foster.*

Ann. of Sci. of Clevel., I, p. 128. Newby., Geol. Rept. of Ohio, Paleont., I, p. 369, Pl. XLII, f. 12, 12a.

Nut long, ovoid in outline, rounded and obtuse at base, acute at summit; section trigonal, the angles marked by ragged salient ridges.

The author remarks that it resembles the fruit of *Bertholletia excelsa*, the Brazilian nut.

Habitat—Upper part of the Lower Coal Measures, Guernsey county, Ohio.

TRIGONOCARPUS SAFFORDI, *sp. nov.*

Nut oval, rounded at the base and there marked by a large triangular slightly flattened impression; ribs three, at equal distance, continuous and equally distinct to the gradually narrowed apex.

This fruit may be the same as the one described above. It differs merely by the ribs not at all prominent, though distinct, separated by two or three obtuse broad striæ, and the sides unequal. The nut is four and a half centimeters long; two of the sides measure two and a half centimeters in diameter in the middle of the fruit, the other only sixteen millimeters. The difference may be the result of compression; the edges of the costæ, also, may have been destroyed by maceration.

The figure of *T. Bertholletiformis* shows the sides of the nut irregularly striate lengthwise, a character not mentioned in the description.

Habitat—Sandstone (conglomerate) above the tunnel, Tennessee R. R., Prof. Jas. Safford. T. 1, of the collection of the Museum Comp. Zool., Cambridge, Mass.

TRIGONOCARPUS MAGNUS, *Newby.*

Geol. Rept. of Ohio, Paleont., I, p. 369, Pl. XLII, f. 11, 11a.

Nut ovoid, or elliptical, large; surface marked by six salient ridges running from base to summit; space between the ridges smooth, and at the base of the nut rising into prominent arches between the depressed base of the salient ridges.

This fine fruit is five and a half centimeters long, four and a half in diameter, broadly ovate, flat or subtruncate at base, more rapidly narrowed to the apex. From the figure, it appears covered by a thick sarcotesta. The six costæ are irregularly striate or rough lengthwise, equidistant and of equal thickness.

Habitat—Sandstone of the coal measures near Coshocton, Ohio.

TRIGONOCARPUS JUGLANS, *Lesqx., Pl. LXXXV, Fig. 4.*

Lesqx., Geol. Rept. of Ill., II, p. 460, Pl. XLVI, f. 3.

Fruit large, nearly globular, marked with three salient ribs; surface smooth, distantly and obscurely lined lengthwise.

The top of the fruit is destroyed and the basilar part immersed into the stone, therefore the characters are not defined. The nut, four and a half centimeters long, three and a half broad, is a nucleus separated from its outer testa. Its surface is quite smooth, like that of a hard shell. It greatly resembles the former species, and may, perhaps, represent its nucleus.

Habitat—Found in a black ferruginous shale, in connection with the coal of Murphysborough, Ill. I found also a specimen referable to this species in the shale over the coal of Cuyahoga Falls, O. T. 11 of the collection of the Museum of Comp. Zool. of Cambridge.

TRIGONOCARPUS HILDRETI, *Lesqx.*

Geol. of Penn'a, 1858, p. 877.

Nut oval, oblong, marked at the base with a large triangular impression mammillate in the center, the angles being conterminous to three narrow distinct obtuse costæ converging to the top; surface hard, smooth, lineolate lengthwise.

The specimen presented to me by Dr. Hildreth is remarkably fine. It is three and a half centimeters long, half as broad, covered with a shelly pericarp not thicker than half a millimeter. The species is far different from *T. trilocularis*, Newby., to which it is identified by this author.

Habitat—Sandstone of the Lower Coal Measures; specimen T. 9, of the collection of the Museum of Comp. Zool., Cambridge.

TRIGONOCARPUS TRILOCULARIS, *Hildreth.*

Amer. Journ. Sci , 1st Ser., v. XXXI, p. 29, f. 4. Newby., Geol. Rept. of Ohio, Paleont., I, p. 367, Pl. XLII, f. 1, 13, 13a; XLIII, f. 13.

Nut ovoid, sometimes nearly spherical. marked with three salient ridges which pass from base to summit; surface between the wings smooth.

The author adds that the ridges are the remains of prominent wings which in a few rare instances are preserved, forming a long triangular point as in his Pl. XLII, f. 1. Within the shell is contained an ovoid nucleus with reticulate surface.

Dr. Newberry's figures appear referable to two different species. F. 1 represents an ovate acute nucleus with borders emerging from the base, enlarging upward and prolonged into a long slightly obtuse acumen as in *Cardiocarpus elongatus*, Atl., Pl. LXXXV, f. 41, much larger however. F. 13, 13*a* represent a large *Trigonocarpus* covered with a thick sarcotesta. It does not seem to have with f. 1 of Pl. XLII a correlation of characters.

I have compared with Dr. Hildreth his specimens of *T. trilocularis*, with the one presented to me and it has been recognized by himself as of a truly different species. In *T. Hildreti*, the nut is larger, oblong or subcylindrical rounded and narrowed to the acumen; the surface lineate.

Habitat—Conglomerate and Lower Coal Measures, Summit, Ohio.

TRIGONOCARPUS PARKINSONI, *Brgt.*

Prodr., p. 137. Parkins., Organ. Rem., 1, Pl. VII, f. 6-8. Schp., Paleont. Veget., II, p. 214.

T. subcylindricus, Lesqx., Atl., Pl. LXXXV, f. 9, 10.

Nut ovate, tricostate, lanceolate-acuminate; basilar impression large, triangular.

The species is represented in numerous specimens slightly variable in size from two and one half to three centimeters long and generally one centimeter broad. The European specimens merely shorter, two centimeters, have the same character. Geinitz identifies the species with *T. Noeggerathi* which, however, from its representation in Goeppert & Berger and also Fiedler, is far different.

From the specimens obtained at Cannelton, it is most probable that the form figured Atl. l. c. as *T. subcylindricus* is a mere variety with longer subcylindrical nuts.

Habitat—Shale above the tunnel, Tennessee R.R., communicated by Prof. Jas. Safford; specimen. T. 8., of the collection of the Museum Comp. Zool., Cambridge. Also found at Cannelton by Mr. I. F. Mansfield.

TRIGONOCARPUS OLIVÆFORMIS, *Ll. & Hutt., Pl. LXXXV, Figs. 7–8a.*

Ll. & Hutt., Foss. fl., III, Pl. CCXXII, f. 1, 3. Schp., Paleont., Veget., II, p. 215.

Nut ovate-acuminate, round or truncate at base, trigonal; testa thick.

In his description, the author says that this species has only three angles instead of six and is more ovate, but that otherwise it is much like *T. Noeggerathi.*

Of the two specimens which I refer to this species, one shows a smooth side, the costa being covered by the thick testa; the other is a truncate nucleus which, from the impression of the truncate base, as well as the lines on the surface of the nut, indicates six instead of three costæ.

Habitat—A large number of these specimens all referable to one species, some with three, others with six ribs sometimes obliterated, were communicated by Mr. J. Collet from the sandstone of Eugene, Ind.

TRIGONOCARPUS MENZELIANUS? *Goepp. & Berg., Pl. LXXXV, Fig. 11.*

Goepp. & Berg., d. Fr., p. 19, Pl. I, f. 5–7. Gein., Verst., p. 43, Pl. XXII, f. 21. Schp., Paleont. Veget., II, p. 216.

Nut round-ovate, distinctly apiculate, tricostate; surface rough not striate.

The fruit resembles in shape Gein., f. 21, l. c. But, in the figure and description of the author, the fruit is rugose, striate lengthwise and the costa obsolete. The nut described here is merely rough, not striate lengthwise and has a distinct medial rib indicating its tricostate character. It is thus doubtful if the reference is correct. The fruit, with a narrow border, is two centimeters long one and a half broad, below the middle, where it is the largest. It is gradually narrowed into a short acumen.

Habitat—The only specimen I have seen was found at Massillon, Ohio. It is T. 14 of the collection of the Museum Comp. Zool., Cambridge.

TRIGONOCARPUS TRICUSPIDATUS, *Newby.*

Ann. of Sci. of Clevel., p. 269, f. 3. Geol. Rept. of Ohio, Paleont., I, p. 368, Pl. XLII, f. 2-6.

Nut elliptical in outline, rounded below, narrowed above into a neck-like prolongation expanded into a three winged area, three costate; nucleus oval, prolonged into a short cylindrical column, crenulate-wrinkled lengthwise.

The costæ of the fruit pass down from the three points of the crowning umbrella-like expansions, and become effaced near the base. The author remarks that as it was probably the case with other species of *Trigonocarpus* this one was surrounded by a drupaceous envelope covered with a leathery rind; two fragments, base of this epicarp are figured. The nut is, in its whole, three and a half centimeters long, one and a half broad. The bottle shaped nucleus is two and a half centimeters long and one broad. It is a fine species, beautifully represented.

Habitat—Roof shale of coal No. 1, Talmadge, Ohio.

TRIGONOCARPUS ORNATUS, *Newby., Pl. LXXXV, Figs. 12, 13.*

Newby., Geol. Rept. of Ohio. Paleont., I, p. 368, Pl. XLII, f. 7, 7a.

Nut elliptical in outline, six costate, constricted above into a neck which is expanded into a stellate six rayed cupped area at the summit.

The six sharp keeled ridges descend from the rays to near the base of the nut, where they become obsolete; three of them are more prominent and prolonged to the base.

This fruit is fusiform or bottle shaped like that of the former species, shorter and narrower. As the author remarks, the fusiform outline of this elegant little nut, its stellate summit, and the six sharp and prominent keels, will enable any one to distinguish it at a glance from any other described species.

Habitat—Sub-conglomerate, Cuyahoga Falls, Ohio.

TRIGONOCARPUS MULTICARINATUS, *Newby.*

Geol. Rept. of Ohio, Paleont., I, p. 369, Pl. XLII, f. 8, 8a.

Nut of small size, rounded below, subcylindrical to the middle, there truncate or broken; surface marked by about twenty longitudinal ridges, three of them more prominent.

The fruit is a fragment from the middle to the base, about of the same size as the former, nearly cylindrical or somewhat contracted below the truncate broken apex. The cross section shows the continuity of the costæ to the center of the fruit which is thus divided star-like in as many sections like parietal placentæ. This character refers the species to the genus *Polypterospermum*, Brgt., Ann. d. S. nat., p. 22, Pl. XXIII, f. 1.

Habitat—Same as the former.

TRIGONOCARPUS GIFFORDI, *sp. nov., Pl. LXXXV, Figs. 5, 6.*

Nut globular, cut at the apex by a deep triangular orifice, indistinctly tricostate, striate by numerous deeply carinate furrows; epicarp very thick with a rough surface.

The nut with its outside testa is nearly three centimeters in transverse diameter, two and a half centimeters from base to top. The epicarp is seen, from its partly decayed state, as composed of thin very hard parallel lamelles, directed from the triangular apex to the compressed base, scarcely half a millimeter thick, sharply edged at their borders, more than two millimeters high, in the middle of the nut and about as distant, the space between them being filled with a hard compact brown matter. In the small patches where the outer testa is preserved whole, the narrow ridges are entirely covered and the surface is rough, slightly striate. Under the epicarp, the endotesta, which appears like a hard shell, is merely marked by obtuse lines, base of the ridges composing the outer envelope. The base of the nut is impressed by three round scars corresponding to the base of the three costæ and passing up to the angles of the orifice of the summit. The costæ are not distinct upon the epicarp but only observable, slightly prominent and obtuse, when the fruit is deprived of it, or decayed in part.

Habitat—Lower coal measures, near Alta, Peoria county, Ill.; found and communicated by Mr. Wm. Gifford.

TRIGONOCARPUS OBLONGUS, Ll. & Hutt., described in Geol. of Penn'a, 1858, p. 877, should be omitted as uncertain, on account of the too imperfect state of the only American specimen referred to this species.

CARPOLITHES, *St.*

Seeds of uncertain relation not referable by their characters to any of the former divisions.

The attribution of these fruits is still more indefinite and varied than it is for those referred to the former groups. Some of them may represent merely the nucleus of species already described from the characters of their testa.

CARPOLITHES BIFIDUS? *Lesqx., Pl. LXXXV, Fig. 16.*

Geol. of Penn'a, 1858, p. 877, Pl. XVII, f. 10. Schp., Paleont. Veget., II, p. 226.

Fruit large, ovate in outline, surrounded by a thick double or triple testa, broadly pedicellate; nucleus oblong, obtuse at base, acute at the summit.

This species is uncertain. I have attributed to it divers forms which are probably referable to different species. As seen by the figure in Atl., the fruit is composed of a broad thick epicarp, seven millimeters or more, surrounding a nucleus three centimeters long, one centimeter in diameter, without any pedicel, while in Penn'a Geol., l. c., the fruit is a broadly pedicellate nucleus? inclined on one side. A large specimen, whose upper part is broken, preserved in the collection of Lafayette College, Easton, Penn'a, is five and a half centimeters broad, with double or triple testa nearly one centimeter thick; the nucleus is oblong, curved, prolonged downward into a pedicel partly covered by the testa. Another is much smaller, but has the same characters as the former, and the nucleus is also prolonged downward into a short pedicel partly covered by the outer testa. Perhaps all these fruits may be referable to *Trigonocarpus Noeggerathi*, as figured by Ll. & Hutt., II, Pl. CXLII, C, whose nucleus is pedicellate, sometimes at least, and surrounded by a very thick double testa.

Habitat—The specimens in the collection of Lafayette College, one of which is figured in Atl., are all from Hazleton. The one described in Geol. of Penn'a is from the coal of New Philadelphia, Penn'a, an upper bed.

CARPOLITHES FASCICULATUS, *Lesqx.*

Geol. Rept. of Ill., II, p. 461, Pl. XLVI, f. 7.
Trigonocarpus rostellatus, Lesqx., ibid., p. 460, Pl. XLVI, f. 6.

Nuts of medium size, smooth, ovate, prolonged at the top into a curved pedicel.

These fruits, nearly two centimeters long, half as broad in the middle, oval, rounded at base, smooth, with a thin coriaceous or shelly testa, were found all at the same locality, many together, distributed as if they had been in connection with a raceme. Most of them are constricted toward the apex as to a pedicel of which I have seen only fragments, none of them attached to the seeds. Fig. 6, l. c., only, has its apex formed of a hooked ridge prolonged downward to near the middle, like a costa. But if these fruits were fasciculate or in racemes, this inflation should represent merely a fold of the testa caused by compression. The two other fruits, though marked in the middle by a narrow linear short furrow, cannot be referable to *Trigonocarpus*. The nuts are generally three, four or more together in close proximity. I have not been able to find any in more evident connection than those of the specimen copied f. 7, l. c.

Habitat—Abounds at Graysville, White co., Ill., Upper Coal Measures.

CARPOLITHES CISTULA, *Lesqx.*

Geol. Rept. of Ill., II, p. 461, Pl. XLVI, f. 5.

Fruit small, oblong, truncate at both ends, bordered by a double elevated testa; nucleus convex in the middle, obscurely costate lengthwise.

The fruit, as exposed upon the shale, is oblong, truncate at both ends, parallel sided, twenty-three millimeters long, half as broad, composed of a double pericarp, the outer half a millimeter thick, the inner narrower, apparently hard, represented by a coating of coaly matter. The nucleus is elliptical, with rounded corners and both sub-truncate ends slightly convex and indistinctly marked in the middle by a logitudinal costa. The fruit looks like a small opened box.

Habitat—Shale above Murphysborough coal.

CARPOLITHES CORTICOSUS, *Lesqx.*

Geol. Rept. of Ill., IV, p. 462, Pl. XXXI, f. 17.

Nutlet small, flattened, mammillate at one end, covered with a thin yellowish membranaceous pellicle; nucleus oval, surrounded by a thick pericarp transformed into crystallized iron.

The whole fruit is one centimeter long, six millimeters broad; the testa two and a half millimeters thick. But for the difference in the texture and the small mamilla, attached a little outside of the base, this fruit would be referable to the following species.

Habitat—Mazon creek in concretions.

CARPOLITHES PERSICARIA, *Lesqx.*

Geol. Rept. of Ill., IV, p. 462, Pl. XXXI, f. 18.

Seed small, in the form of a narrow lozenge, marginate at one end, acute at the other; nucleus distinct, of the same form, bordered by a comparatively broad, thick testa.

The whole fruit is one and a half centimeters long, half as broad in the middle. The compact testa or margin, one to two millimeters broad, is enlarged on the sides of the nucleus which is apparently of a softer texture, being partly destroyed.

Habitat—Shale of the coal of Murphysborough, Ill.

CARPOLITHES ACUMINATUS, *St.*

Fl. d. Vorw., I, Pl. VII, f. 4. Lesqx., Geol. of Penn'a, 1858, p. 877.

Seed small, narrowed up from a rounded base to a sharply acuminate apex; surface smooth or shining, hard.

The seeds referred to this species are five millimeters long, three millimeters broad toward the inflated round base, often smaller, preserved imbedded into the shale in their original state of turgescence, never flattened. They are generally largest near the base, gradually narrowed to a sharp acumen, sometimes oval-oblong, acuminate at one end, obtuse at the other.

Habitat—I have seen them at divers localities, but especially upon shale of the lower coal of Trevorton, Penn'a.

CARPOLITHES RETUSUS, *St.*

Fl. d. Vorw., I, Pl. VII, f. 10, 11.
Cardiocarpus retusus, Newby., Geol. Rept. of Ohio, Paleont., I, p. 374, Pl. XLIII, f. 6.

Nucleus oval, strongly rugose, emarginate at the apex, with a small cicatrice at the base.

Prof. Newberry remarks that Sternberg's figure is more rounded at the apex than in his specimen and destitute of the striate border.

This and the two former species may be referred to *Rhabdocarpus.*

Habitat—Shale over coal N. 1, Talmadge, Ohio.

CARPOLITHES FRAGARIOIDES, *Newby.*

Geol. Rept. of Ohio, Paleont., I, p. 370, Pl. XLIII, f. 2, 2a.

Nucleus spherical in outline; surface marked with a kind of net work of smooth bands with areoles which form a double spiral; outer testa apparently drupaceous with coriaceous rind.

The nucleus is one and a half centimeters broad in the middle, a little less in a vertical direction. It seems to bear at its base a short pedicel. According to the author, the figure of the nucleus gives a very imperfect idea of the marking of the surface. The shelly envelope f. 2 is separated from the nucleus, but both are so associated in one locality as to render it almost certain that they belong together.

Habitat—Shale over coal No. 1, Mill creek near Youngstown, Ohio, Dr. Newberry.

Species of uncertain attribution.

CARDIOCARPUS TREVORTONI, *Lesqx.*

Geol. of Penn'a, 1858, p. 876.

Nuts flattened, broadly obovate, sub-emarginate at the base, acute or acuminate to the apex, marked in the middle by a sharp elevated line, very smooth.

Habitat—Trevorton, Penn'a.

CARDIOCARPUS PLICATUS, *Lesqx.*

Geol. of Penn'a, l. c., p. 876, Pl. XVII, f. 9.

Differs from the former by its undulate plaited convex surface, without medial line, probably a variety of the former species. These fruits one and a half centimeters broad in the middle and as long, are not rare at Trevorton and variously shaped according to the degree and bearing of compression in the shale. They should be described as *Carpolithes.* Some of them are like the nucleus of *Trigonocarpus olivæformis* Ll. & Hutt., when crushed; or may be referable to *Carpolithes sulcatus* of the same author as figured III, Pl. CCXX, f. 1–6. But they are never costate, while f. 1 of Ll. & Hutt., is tricostate or a *Trigonocarpus.*

Habitat—Shale of the lower coal at Trevorton, Penn'a.

CARDIOCARPUS PUNCTATUS? *Goepp. & Berg.*

De Fruct., p. 24, Pl. II, f. 26. Lesqx., Geol. of Penn'a, (1858,) p. 876.

Fruit flattened, round, emarginate or reniform; surface marked by elevated points regularly placed in quincunxial order.

Merely differs from the figure of the author by the regular disposition of the dots. I have seen only the specimen described, and Goeppert's species is also from a single specimen. It is uncertain.

Habitat—Shale of the coal of Muddy creek, Penn'a.

CARPOLITHES SPICATUS, *Daws.*

Dev. Pl. of Maine, Quat. Journ., Geol. Soc., 1863, p. 461, Pl. XVII, f. 15.

Carpels or spore-cases oval, about three millimeters in length apparently with a thick outer coat, densely placed on a thick rachis.

The author further says: "That this is evidently a spike of fructification, and may be allied to his *Trigonocarpus racemosus*, and that it more resembles the fructification of *Annularia* or *Sphenophyllum* than any fossil fruits known to him. He further remarks that its parts are too indistinct to admit of minute description, and that the two ranked appearance of the seed is probably deceptive."

I have specimens, which I consider as identical with this species, from the Vergent or Chemung red shale near Shamokin, Penn'a.

Habitat—Perry, Maine, Devonian.

CARPOLITHES LUNATUS, *Daws.*

Dev. Pl. l. c., p. 464, Pl. XVII, f. 11.

Base rounded regularly; apex broadly truncate and mucronate; nucleus surrounded by a narrow margin.

The seed, seen from the figure, is quite flattened, seven millimeters in diameter at its truncate apex, vertically four millimeters. It has a semi-lunar shape, is apiculate at the base, and in the middle of the transverse line or diameter.

Habitat—Same as the former.

CARPOLITHES ? SILIQUA, *Daws.*

Dev., Pl., l. c., p. 465, Pl. XVII, f. 4.

Elongate, smooth, flattened; sides slightly sinuate, three to four millimeters in length, five millimeters in breadth.

The author adds that these objects are too thick and carbonaceous to have been fronds or leaves and too regular in form to be fragments of stems, and that they may have been small extremities of roots.

The figure is much like that of *Lepidocystis fraxiniformis*, Lesqx., Atl., Pl. LXIX, f. 21. The body is somewhat narrower and the sides more undulate. This species is extremely abundant in the Pocono below Pottsville, Penn'a, and is most variable in size and shape. Some of these specimens have the same form and size as the figure given by the author.

Habitat—Same as the former.

These three species are too insufficiently represented. Prof. Dawson published them in order to help the geological determination of the strata where they were collected.

Besides the fruits described above, I have seen in different collections, and also have in my possession a large number of specimens of seeds whose descriptions are omitted here, either from their imperfect state of preservation or from the difficulty of clearly defining their characters without an elucidation by figures.

Among them there is especially a fruit which appears to represent the Genus *Codonospermum*, Brgt., An. d. Sci., l. c., p. 24, at least by its likeness to the beautiful figure given of a seed of this kind by Grd'Ey, Fl. Carb., Pl. XV, f. 5. The fruit, six to eight costate, is bottle shaped, abruptly contracted above the middle to a truncate or nearly flat top, more inflated and rounded at the base; the costæ, distinct but narrow, are converging to the top and to the base. The seed is a little larger than represented by Grd'Ey, three and a half centimeters long, two centimeters broad below the middle, contracted to one and a half above it, the costæ being five millimeters distant in the middle of the fruit, and the space between them smooth even polished. It seems that it was enveloped into a fleshy sarcocarp, as flakes of a thin membranaceous like substance are irregularly spread along the borders, especially toward the upper part of the seeds, seemingly remains of a compressed partly dissolved vascular tissue.

These specimens are on a piece of shale from Cannelton, communicated by Mr. I. F. Mansfield.

GENERAL REMARKS.

CHAPTER I.*

On the nature of the vegetation of the Carboniferous era, and its agency in the economy of the world.

§ 1. Having described the plants of the Carboniferous age, from a study of their remains in the coal measures, it seems advisable to consider the vegetation of that age as a whole; first, in its nature compared to the characters of the flora of our epoch, and to its function in geology as the prime agent producing mineral coal; and then in regard to the distribution of the species, geographical and stratigraphical.

The first will be essayed in this chapter. In the next chapter we will see how far the ancient distribution of species can be inferred from the present distribution of their remains; and how far we can go in assigning separate fixed horizons in the vertical columns of the rocks to individual species or groups of species.

§ 2. The coal flora was made up 1, of Cryptogamous plants: *Filices* or Ferns, *Lycopodiaceæ*, *Equisetaceæ*—and 2, of *Sigillariæ* and *Cordaiteæ*: two groups or families of uncertain affinity to recent plants, but generally accounted Gymnosperms of peculiar conformation, related to the *Cycadeæ*, and partly, perhaps, to the Conifers.

§ 3. The *Lycopodiaceæ* and *Equisetaceæ* of the present epoch are represented by plants of small size, sparingly distributed over the whole world, with stems no larger than a man's finger.* But in Carboniferous times all of them were of greater size, most of them large trees.

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* This chapter owes precision of style and lucidity of expression to Prof. Lesley, who had the kindness to give to my first draft a careful and thorough revision.

The *Lepidodendron* trunks measured from six to thirty centimeters in diameter, and were proportionally high.

The *Calamites* were smaller trees, with stems ten to thirty centimeters thick; their growth was extremely rapid; and they stood crowded close together as now in the southern swamps the *Canes*, which cover the surface of the ground with a dense mass of vegetation rising high into the air.

Ferns have been called the most conservative beings of the world. The Ferns of the coal flora resembled in some of their characteristic features the Ferns of the present day, as they are seen in the humid tropics. But their growth was far more luxuriant. Many of them were virtually trees, in size and aspect, far exceeding the noblest of existing Fern-trees; and none of the bushy Ferns we have now can compare in dimension with those of the Carboniferous.

The *Cordaiteæ* and *Sigillariæ* also were, in the main, trees of great size.

The *Sigillariæ* were interspersed among the *Lepidodendron* and Fern-trees.

The *Cordaites* formed dense forests, quite comparable for their distribution to the pine woods which shade with gloom the tide-water region of the Atlantic and Gulf States.

§ 4. The character of such a vegetation expresses the conditions of atmospheric influence under which it grew.

Judging by the habits of their living relatives, these ancient plants grew partly immersed in the shallow water of extensive swamps.

Some, like the *Sphenophyllum* and *Annularia*, stretched their stems and expanded their foliage upon the surface of the water, while the *Calamites* leafed out above them.

Others, like the *Sigillaria* and *Lepidodendron*, while rooting in the swampy vegetable mould, or borne upon a solidly compacted raft of creeping *Stigmariæ* afloat upon the lagoons, lifted their cimes aloft high above the underwood, seeking sufficient light and air for the due unfolding of their leaves. We know that their leaves were soon deciduous; for we generally find them preserved at the extremities of the branches only.

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* The largest living *Equisetum* (Horse-tail), *E. xylochoeton* of Peru has a stem about ten feet high and two centimeters in diameter.

But all, without exception, *Cordaites*, *Sigillaria* and Ferns, were swamp plants, and that in more than the mere sense of living in or on a marsh; they were themselves so impregnated with moisture from the super-abundant humidity of the surrounding atmosphere, that they must have produced boggy ground even on elevated land, were there any such at that time.

§ 5. In the leaves of the coal plants we read their history.

The *Lepidodendron* had lanceolate-acuminate, small leaves, analogons in shape and function to those of Conifers.

The Fern-trees had huge fronds, curved downwards like umbrellas, displaying to the influence of the air a wide surface, sub-divided into branches, leaves with minute lobes, teeth, and even hairs. In this manner they multiplied their points of contact with the air for the condensation and absorption of its nourishing elements.

The bushy Ferns had large undivided leaves, and constituted an undergrowth like that of the swampy valley bottoms of the Amazon, or like that of the lowlands of tropical islands like Cuba. Exotic Ferns now thrive in our conservatories only in an atmosphere of great humidity and of moderately warm but uniform temperature. I say moderately warm; for there are regions in our temperate zones, the exceptional humidity of which effects without the aid of a high temperature a luxuriant growth of Ferns, suggestive of the vegetation of the tropics. Thus Schimper says:*

"Nothing is more surprising than the Fern vegetation of Killarney, Ireland, where one sees, united to sub-tropical types like *Hymenophyllum Tunbridgense* and *H. Wilsoni*, the graceful *Trichomanes radicans* covering rocks and trunks of trees with European species whose luxuriant growth, unknown elsewhere, have here, by their dimensions, the aspect of tropical Ferns."

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* Paleont. Veget. I, p. 358.

The Fern-trees of the present age show plainly enough by their geographical distribution what sort of atmosphere they require for their prosperity; for they are seen especially inhabiting such mountain slopes and summits as are bathed in fog and cloud; and affecting such altitudes as suit the periodical condensation of prevailing winds. The upper and lower limits of the Fern-zone on the Sandwich islands are distinctly defined, and mark the upper and lower limits of the zone of condensation. So it is in the islands of the Gulf of Mexico, on the mountains of tropical Asia, and in fine wherever the Fern-trees are known to grow.

The *Lepidodendron* leaves, small, linear-lanceolate, acute or acuminate in shape, presented an unusually large surface to the air, compared with other leaves. They could condense and absorb more vapor. The abundance of *Lepidodendron* in the coal age, therefore, indicates a prevailing humidity of climate. Our Conifers, with leaves constructed on the same principles, thrive especially well along our southern seaboard, covering it in fact with an immense forest. We find them also on the tops of our mountains; on the plains of the north, which are so often covered by fogs and clouds; along the rocky sides of small streams, and especially in boggy places, where Tamarack and Bald-cypress root themselves, like the ancient *Sigillariæ*, in the swamp mud.*

§ 6. The sameness of the types of coal plants in all countries where coal beds have been found and examined, proves the prevalence of an invariable or uniform moderately high temperature during the coal age, just as plainly as the facts stated in the preceding paragraphs prove the prevalence of great atmospheric humidity. The exuberant coal flora of Spitzbergen in 80° N. latitude, that at the equator, that also in Australia, have a common facies.

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* On this subject and that of the influence of humidity upon the production of wood, most interesting researches have been made in various countries, especially in France. The celebrated chemist and physiologist, Chevandier, discovered by numerous experiments that the woody mass of a pine tree, one hundred years old, growing in a dry rock fissure, exposed to the south, amounts to only 1.25 steres (cubic meters=about 50,000 cubic inches, or 1728 cubic feet); while with the same situation and exposure, if some accident of surface retains the drainage for its use, such a tree will produce wood to the extent of 3 steres; and if a neighboring stream gives an abundant supply of water, both by contact with the roots and by evaporation to the foliage, the woody mass will amount, in a hundred years, to 4.15 steres.

From the coal measures of Barren island, in 74° 30′ N. latitude, Heer has identified two species of *Cardiopteris*, *Palæopteris Rœmeriana*, *Sphenopteris Schimperi*, all found in the coal beds of Germany; *Lepidodendron Weltheimianum*, *Stigmaria ficoides*, two *Cyclostigma*, *Knorria imbricata* and *Bornia radiata*, species abundant in the lower coal measures of America, as well as of middle Europe. And the same types have been observed in the coal beds of Spitzbergen.

§ 7. The cause of this great uniformity of temperature, which seems to have prevailed over the whole surface of the globe in early geological ages, or at least during the Carboniferous times, I am not called upon to discuss. Several hypotheses have been offered. But it seems clear enough that extensive low lands, alternately and very slowly rising and sinking near to sea level* surrounded or subdivided by extensive reaches of open water, must have had a warm wet climate, far more uniform than any climate which the present distribution of continents and oceans presents to our examination.

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* The long Paleozoic subsidence, during which from twenty to forty thousand feet of Silurian and Devonian strata were deposited, ended with the coal formation and was followed by a general elevation in the Permian age, by which our Appalachian mountain system was inaugurated. During the deposit of three thousand feet of coal measures, there must have been either oscillations of land (or of sea), or else stages of arrest of subsidence, marked by successive coal beds. Whether the vegetation of a coal bed took place at the precise sea level, or at moderate heights above sea levels, or on swampy plateaux at still higher levels, the supposition of its subsequent submergence is rendered necessary to explain the sandstone, shale, and limestone strata which now lie over it. And every coal bed in the series calls for a repetition of the process. The story of the older coal is repeated word for word in that of the Lignite of the West, occupying a wider expanse of earth surface than the ancient coal fields. Along the eastern base of the Rocky mountains the Lignitic strata have the same distribution and the same characters as those of the Carboniferous, in mineral constitution and in vegetable properties, although the plants of which the lignite beds are composed were very different from the plants of the Carboniferous age. Here and there the Lignite formation was rent and penetrated by volcanic eruptions; and after the Tertiary formation was deposited the entire region of the west was elevated, as the region of the east had been at the close of the Carboniferous era, and the lignite beds were folded and broken in various ways, and tilted sometimes even vertical.

§ 8. An excess of carbonic acid in the coal age atmosphere must be added to an excess of moisture, and a uniformity of temperature, if we would complete the explanation of the vegetable growth of coal.

The preponderance of this acid in the air is as favorable to vegetation as it is hostile to animal life. Such a preponderance would at least help to explain the more magnificent proportions of the coal plants, such as they were, and the remarkable scarcity of animal land forms in the coal measures.

Except some batrachians and insects, no air-breathers seem to have inhabited the land.* It is rightly called the Age of Plants, for earth's atmosphere was then not only fitted in the true ways just specified, to nourish vegetation, but unfitted to nourish any other kind of life.†

§ 9. Of the exuberance of the Carboniferous vegetation, the great thickness of some coal beds is indeed sufficient evidence.

The almost incredible quantity of vegetable matter needful, on the hypothesis that a large coal bed is merely a compacted mass of the fallen trunks, roots, branches, and leaves of a growth in situ, has especially excited opposition against it.

But such opposition must succumb to positive evidence presented for examination in our own day in the case of a kind of vegetation quite comparable to that of the Coal period. One has only to penetrate the cedar swamps of the north, or the Dismal swamps of the Carolina seaboard, to comprehend the degree of activity to which vegetable life may rise under certain circumstances.

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* See J. W. Dawson, The Air-breathers of the Coal Period, 1863. E. D. Cope, Geol. Rept. of Ohio, Paleont., vol. II. S. H. Scudder, Palæozoic cockroaches, Boston Soc. of Nat. History, vol. VIII, p. 1, No. 3.

† To the same cause may be attributed the scarcity of remains of mammals in the Eocene lignitic formation. During its prevalence large Saurians of the Cretaceous were still inhabiting the bogs; but very few remains of land vertebrates have been discovered in that group.

The surface of a cedar swamp is covered by decaying trees and shrubs, heaped together in every stage of decomposition, and at every angle of inclination. This surface-heap is from four to ten feet thick. To make one's way across such a swamp is sometimes impossible and always a most difficult feat. Even the aborigines preferred to make a detour of thirty miles around it, to crossing such a swamp only three miles wide.

In the south, large trees, especially the Magnolia and the Bald Cypress (*Taxodium*), grow at distances upon the bogs; but the underwood is mostly a compound of *Canes* from twenty to thirty feet in height, crowded so closely together that a path must be forced with the hatchet.

What then must have been the mass of vegetable remains heaped upon the surface during a coal period when growth took place under circumstances twice as favorable as in our great swamps.

Could we then show proof that the remains of Carboniferous vegetation were thus heaped upon the ground, that additions to the pile were constantly made for a long time, and the whole transformed into coal by slow degrees afterwards, the problem of the formation of a coal bed would be satisfactorily explained. This I will now attempt:

§ 10. The transformation of the woody substance of dead plants into ulmine by oxidation takes place everywhere in comparatively dry air, ulmine being a constituent of the humus or common earth.

When the dead woody fiber however is shielded from the more energetic action of the atmospheric oxygen by immersion in saturated wet air, or under water, it escapes decomposition for an indefinite length of time, and is gradually transformed, by a sort of eraumacausis or slow burning, into a soft black material, composed of the same elements as wood. The substance of peat consists of this soft material. In time and under pressure it grows more compact, like lignite, and then becomes dense hard coal. Finally, by the loss of its more volatile hydrocarbons it passes into anthracite.*

§ 11. In the peat bogs of our time, the transformation of the woody matter takes place either under water, or beneath a water-soaked spongy covering, precluding the access of air.

On the slopes of mountains, protection is found in the air itself, surcharged as it is with water in the condition of fog.

In the great humidity of the carboniferous atmosphere we find then the first cause of the preservation of carboniferous vegetable remains and their conversion into coal. For, the heaps of fallen vegetation became, by absorption, reservoirs of water, protecting themselves against rapid oxydation. Afterwards when actually submerged and covered with sheets of mud, sand, gravel, etc., their protection from destructive oxydation became perfect for all subsequent ages, even after the elevation of the continent high above sea level.

The process was a simple one; and being repeated in our sight at the present time, can be studied at leisure, and admits of no dispute.

§ 12. First, as to objections based upon the great thickness of some coal beds.

It has been thought that this necessitates the hypothesis of the transportation from a distance, by water, in various ways of at least part of the materials and the heaping of them together upon the sea bottom or in lakes.

It has been thought necessary also to imagine large contributory accumulations of macerated marine plants, the growth of which was as prodigiously active then as it is now.

§ 13. The second part of the hypothesis can be disposed of in a few words.

It is certain that nature takes good care of all that it produces, so that no particle of matter is really lost. It is certain that marine vegetation has its purpose and end as much as that of the land. But nature, even in its multiplicity of recompositions, cannot produce a new compound from elements which have no existence in the matter under decomposition.

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*Liebig says that woody fiber decomposes slowly even in the air, the oxygen of which unites with the carbon of the plants to make carbonic acid gas; but with extreme slowness under water, because in this case hydrogen combines with the carbon, hydro-carbon gasses being evolved, and a mass of uncombined carbon remaining behind.

All the hydrophytes (water plants) whether of fresh or salt water are merely cellular in structure; have no fiber, no woody element. Land plants* on the contrary are composed of vascular and cellular tissues in different proportions Transformation of the cellular matter into various more or less valuable substances, acids, ulmine, empyreumatic oils or resins, takes place first, the woody fibers being left behind.

In the decomposition of Algæ the entire mass undergoes one and the same transformation: that to which only the cellular tissue of land plants is subjected, without any residuum of woody fiber whatever. Algæ can therefore produce nothing in the shape of coal—nothing but liquid fuel, oil.

Their decomposition moreover is so rapid, that when sea-wrack is gathered for manure it has to be spread upon the fields at once; otherwise, as farmers say, it melts and loses its fertilizing properties.

The Algæ cannot be preserved against decomposition any more than can the fleshy parts of animals. They cannot burn nor emit any amount of caloric.

Add the geological fact that all remains of plants found either in the shales which cover coal beds or in the body of the coal itself are land plants, with woody fiber, and the demonstration is complete that however vast the accumulation of decayed vegetation in a coal bed, none of it is that of marine vegetation, Algæ or cellular plants; but all of it is that of air breathing land plants. out of the vascular tissue of which was formed the coal.

§ 14. As to the ability of a standing vegetation to supply all the material of a coal bed, on the spot, without need of other transported matter from a distance, it is only necessary to refer again to what I have written above respecting the heaped droppings of modern cedar swamps, the luxuriance of which must certainly be far inferior to that of the Carboniferous swamp-forests, in ability to produce wood. Those who have not explored the mode of growth of peat, or perhaps even visited a peat bog, cannot conceive the magnitude of the results of such a vegetation. To be well understood, it must be studied in marshy places of difficult access, even dangerous to approach, and therefore, under circumstances which few naturalists care to encounter. A volume could scarcely suffice to contain the observations to be made on the subject. I will merely quote some figures, to give an idea of the quantity of vegetable wood produced under different circumstances.

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*Plants rooting in water, but upraising their stems or rhizomas to the surface of the water or above it, are land plants in substance; for their growth is produced under atmospheric action.

§ 15. Researches and experiments, made by the Department of Forests of France, show that in one hundred and twenty years, one acre of forests =forty-three thousand five hundred and sixty (43,560) square feet* produces twenty-two thousand and eighty-five (22,085) cubic feet of pine wood, weighing (at thirty pounds per cubic foot) six hundred and sixty-two thousand five hundred and fifty (662,550) pounds.

One acre of a peat bog, with an estimate average growth of one foot in one hundred and twenty years, produces 43,520 cubic feet, which, when dried and compressed to a density of twenty pounds per cubic, (at which peat has the same heat power as pine wood at 30 pounds,) weighs 871,400 pounds, or 208,750 pounds more than pine wood.

It may be easily admitted that the production of vegetable matter in the coal age was twice as active as now, that therefore twice as much woody fiber was grown to make coal; and therefore again, that one foot of coal could have been produced in one hundred and twenty years.

This amount, one foot, is adopted as a basis of calculation in view of the compression and prolonged decomposition of the vegetable mass; being one half the thickness produced in a given time assumed in the case of peat; with a heat power double that of peat.

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*The measures are reduced to American standard.

The annual layers of peat, measuring one inch at the top of the bank, are compressed so as to measure about one tenth of an inch at a depth of only ten to twelve feet beneath the surface; while the layers of a coal bed are often seen to measure only the twentieth of an inch (one millimeter). This shows that the swamp growth of the coal age was twice as rapid as that in our peat bogs; and that two and two thirds as much combustible matter was formed in a given time than is formed in the same length of time in one of our modern forests.

§ 16. Viewing the subject in the light of these facts, all the objections urged against the analogy of the production of the coal to the growth of peat can be set aside; since Nature uses at the present day the same methods for arriving at the same results.

Everybody living on the borders of a peat bog, knows of its growth. Records of pre-historic human races, and of men of later historical times—relics of the stone, the copper, and the iron ages,—Celts, Gauls, and Romans—are found in layers of peat at various depths beneath the surface of the bogs; and the rate of growth of the matter has thus been approximately ascertained.

In Germany, Holland, England, etc., the surface of extensive peat bogs has been triangulated and leveled repeatedly to ascertain its gradual elevation; and not only have such measurements verified the fact, but the estimated rate of growth thus obtained has corresponded to the computed amount of surface matter produced in a given time by the vegetation of the swamps.

§ 17. For a comparison of the great thickness of some coal beds with that of deposits of peat at the present time, the data are quite explicit.

There are deposits of wood, mined in Denmark to the depth of seventy-five feet, formed by successive and alternate growths of peat and forests on the same spot.

Other true peat bogs in Sweden and Russia have been ascertained by borings to be more than one hundred feet thick; the whole mass composed of ripe black combustible material.

Such a mass, subjected for geological periods of time to the process of slow burning and condensation under superimposed deposits of sand and clay, would constitute a bed of coal from thirty to fifty feet thick.

As such enormous accumulations of woody matter are seldom observed on the present surface of the globe, so also coal beds of corresponding size are rare in the Coal Measures. The average thickness of peat growing under favorable circumstances (as for example, along the shores of the Baltic and North sea) is not more than ten or twelve feet; and this corresponds in solidity to a thickness of five or six feet of a coal bed, which is a common size, although the average thickness of all the coal beds in Pennslvania falls much below five feet.

§ 18. *Coal not a Delta deposit.*—The vegetation of the Coal epoch, as remarked above, was every where governed by the same atmospheric circumstances, and had the same character. There is nothing in the Coal Measures themselves to show the existence of high mountains. There would follow an absence of considerable rivers, capable of transporting heavy materials. The land was either stationary or continued its slow and gradual movement of upheaval, bringing up the surface to near or above the level of the water, where, in shallow basins, shielded against the invasion of the sea by sand walls, the woody material were heaped during varied periods of time. Or contrarywise, the land was gradually sinking beneath the ocean level submerging one coal bed after another, and furnishing temporary sheets of open water to receive the intermediate deposits of sand and mud. But during the stage when the ocean level remained stationary, and the coal bed was growing, lagoons or irregular water channels traversed great extents of the area.

It is therefore impossible to understand wherefrom the remains of the vegetation should have been derived for transportation; and still more so to account for their transportation itself.

It is only necessary to contemplate the action of our present great rivers, the Mississippi or the Amazon, to see that the woody matter which they bring from afar and deposit in their deltas is not concentrated in masses or layers by itself, but on the contrary is scattered and distributed throughout thick layers of sandy mud deposited from the turbid water in which the wood floated. The drifted materials of deltas and delta islands composed of sand, mud and trees intermixed cannot constitute a bed of coal.

§ 19. To meet this difficulty Bischoff supposed a sifting process ; the heavier material constituents coming to rest in dead water first, the clay next and the vegetable float (trees, leaves, etc.) last, in the form of a layer covering the others.

But if this view were tenable, then, 1. Each coal bed would represent a single case of transportation, one season of freshet, one year ; and the number of layers of coal in the coal measures would be practically infinite. 2. Each coal bed would be more impure at the bottom and increase in purity towards the top. How contrary to facts both these conclusions are, everybody knows.

Moreover, such a deposit as the Pittsburgh coal bed would be an impossibility. For, whence could come sufficient float vegetation to form a layer fourteen thousand (14,000) square miles in extent, and averaging eight feet in thickness ? We cannot imagine fourteen thousand square miles of forest carried down some mighty river, or system of rivers, to make it. But even if we could, that amount of forest would suffice (in bulk) for only one foot of coal ; the remaining seven feet would remain unaccounted for. The necessary supposition, that the whole event took place at once, in order to obtain but one coal bed is rendered, incredible by the regularity of the bed over its immense area.

§ 20. By the slow decomposition of the plants in passing into coal, they lose their form, and are generally converted into a homogeneous compound in which none of their characters can be recognized. But even in this condition they can be studied and determined generically, by submitting the coal to the action of acids, by which the woody fibers are loosened and separated.

In the case of some coals, thin lamellæ of fibrous dry charcoal interposed between the layers of compact bright coal, form clearly drawn pictures of the outlines and nervation of Ferns. Often also the forms of vegetable stems and trunks converted into sulphide of iron (pyrite,) remain unimpaired even into compact coal.

§ 21. But the most of the well preserved remains of plants are found in the laminated shales overlying the coal beds. These roof shales were always deposited at the end of the life of a coal bed, when the swamp had been invaded by water so rapidly or to such an extent as to first lessen the activity then stop the growth of its whole vegetation.*

The invading water being more or less turbid but moving in all directions with extreme slowness, while its surface was exposed to daily evaporation, deposited successive thin layers of mud between which were locked up and in time pressed flat the dead leaves, twigs and the stems, which floated for a while at the surface and gradually rested at the bottom. Most of these were detached from plants still growing around the swamps, or upon hammocks and knolls still unsubmerged, and constituting so many islets in the water. As soon as they were inclosed separately between layers of mud and protected from any further rapid decomposition they became subjected to the process of petrifaction by infiltration of earthy elements in their tissue.

It is chiefly then upon the surfaces of these laminæ of shale that the history of the composition and formation of coal is written in beautiful hieroglyphics, the letters of which are leaves, branches and trunks of trees ; and the deciphering of the language thus preserved constitutes the science of Palæobotany.

In other kinds of deposit such as sand, the woody material, especially that of tree trunks, was first slowly softened by a decomposition hastened by the porosity of the embedding matter, and then gradually re-placed by elements held in solution by the water ; in the end nothing being left of the vegetable but the print of its bark ; and this is what is most commonly seen in the coal-measure sandstones.

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* Similar deposits of shale occur also in the body of a coal bed, and mark interruptions of the growth, not fatal to the whole bed, but only to the growth in patches or belts here and there throughout the swamp.

In other cases silica or carbonate of lime has taken the place and the form of the tissue of vegetable remains, the structure of which can thus be studied if the mass be thinly sliced and placed under the microscope.

Transformations of this kind were not rare in the coal age, and they would suggest a greater amount of silica held in solution in the waters then than now, did we not know that the silica of the sandstone itself is taken up by the percolating rain water and redeposited at certain points where chemical changes are going on.

Whole forests of silicified Fern-tree trunks standing in the place where they grew, are found in sandstone beds of the Coal Measures; for example, on Shade river, south of Ohio, or along the Great Kanawha river, Kentucky, from Charlestown to its mouth. In these trunks the whole matter is silicified by a chemical process such as has converted into stone the famous stone forests of the desert between Cairo and Suez in Egypt, and of Colorado, the Yellow Stone, and other countries of the west.

The texture of the wood is distinctly preserved and can be studied by anatomical process as distinctly as in the wood of living plants.

In other cases, as on the shore of the bay of Funda, and at the west of Cape Breton, the standing trunks have been converted into stone by infiltration of sand and mud; as is generally the case for the trunks of *Lepidodendron* and *Sigillaria* which have left only the impression of their bark into sandstone and clay. When the trunk of standing trees is decaying in the inside, the bark may remain firm for a length of time, and the sand and mud either percolate through it, or when the stems are broken short the earthy matter is poured into them, and fill the hollow pipe with a mould or cast of sandstone or of clay.

This is proved not only by the character of the cast and the coaly envelope of bark which is sometimes preserved, but also by the discovery of insects and invertebrate animals inside the stem at its base.*

Other plants (as well as animals) have been preserved in nodules of carbonate of iron, the origin of which is to be ascribed to Diatoms or infusoria, congregating and building up around the vegetable fragments or dead animals, enclosing them in the end completely, and preserving their surface characters with a remarkable minuteness of detail. These concretions are widely scattered through all Coal Measures, but are especially abundant near Morris, in Illinois, on Mazon creek, the name of which occurs, therefore, frequently in the descriptive part of this volume.

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* Occurrences of this kind are observable at our time on the borders of some peat bogs. Drummond lake, in the middle of immense deep peat formations of the Dismal swamp, in Virginia, has its borders gradually sloping into the water. At a distance of the outskirt, trees from *Taxodium* (Bald Cypress,) have the base of the trunks immersed three to five feet or more in the lake. The vegetation of the trees is thus impaired by deep water, their tops are mostly decayed, all are hollow. Some of them are broken at or near the level of the water; others have their bark partly cleaved at or below the surface of the water; most of them are filled by decayed remains of plants, leaves, cones; or of animals, shells, even skeletons of fish, which, first floating at the surface, have entered the hollow trunks, and thence sunk to the bottom. In that way, some trunks are filled with mud, and remains of organic matter, to a depth of a few feet below the level. Diving the full length of the arm into the hollow from the boat, I could rarely reach the bottom of these deposits. The bark is the most tenacious part of the tree, longer resisting against decomposition. In the old peat bogs, flattened sheets of bark are often found hollow or without wood. In the tertiary lignite there are deposits of woody matter, heaped as mud at the bottom of the basins, while bark separated from the wood a pulpy mass, covers in hollow flattened cylinders, the decomposed woody substance. In the Coal Measures, the bark of *Lepidodendron* and *Sigillaria* is sometimes found superposed in layers without alternance of coaly matter.

CHAPTER II.

On the Geographical and Stratigraphical distribution of the plants of Carboniferous age.[*]

§ 22. The uniformity of temperature, and of other circumstances of climate in Carboniferous times being taken for granted, as described in the foregoing chapter, a general uniformity of vegetation over the whole expanse of land surface becomes a probable inference.

But that the flora was nevertheless greatly diversified in species is well proven by the fossil remains already known to us. And very naturally; for a diversity of characters in plants is the certain result of a diversity of local circumstances: some species thriving at the surface of water; others under the shade of trees; others in open land, and so forth.

The general uniformity of Coal vegetation, then, must be understood as including such local and circumstantial diversities; the same kinds of plants prevailing in all places of the region where their peculiar dispositions were favored. In other words, each species had its habitat, not in any one special restricted part of the region, but in a greater or less number of suitable localities scattered over the whole.

The *geographical distribution* of the Coal flora is expressed then, by referring the various species growing at any given date or stage of the Coal era to the various localities in which they grew.

§ 23. One would naturally admit a priore that the characters of the vegetation changed in the lapse of time, so that the same plant forms should not be found in the higher strata which are found in the lower.

The Carboniferous age must have been a very long one, judging by the thickness of the coal beds, and the great variety and size of the sandstone, shale and limestone strata which are interposed between them. During so long a time the coal flora must have gone through many modifications; whether by the alteration of types; or by the disappearance of some species and the introduction of others.

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[*] Edited by J. P. L.

The *Stratigraphical distribution* of the Coal Flora, then, is revealed by a study of the various species proper to the different coal beds in their relations to one another as upper and lower beds, newer and older beds. It is that which appears up and down the pile of Coal Measures, during the entire length of time occupied in their deposit.

The *geographical* distribution is that which existed over a horizontal surface at some one given time.

The study of this *vertical distribution* is the more important one, because it may afford data for distinguishing each individual coal bed, and for tracing such a bed from place to place, and identifying it at distant localities. This is its practical value.

Its scientific utility is evident; for it must needs furnish significant materials for solving the problem of organic development, by showing the *succession of vegetable types in the course of time.*

It is clearly impossible, however, to ascertain what changes took place in the flora of successive coal beds unless the entire flora of each bed in its whole extent be well known. It is not enough to know the various species of each bed in one locality, comparing them with the species of superior and inferior beds in that locality; seeing that the circumstances of growth may have changed or oscillated from time to time at that spot, and the character of the flora of course with the character of the circumstances.

The remains of the plants are only found in the roof shales of a coal bed. Its flora is now known only from these remains. But the species found in the roof shales of a bed in a given place must not be taken as a complete inventory of all the species growing in that bed at one time over the whole expanse of that bed. It will be only a local inventory of such of them as were then growing in that particular part of the bed. Many other species were growing at the same time elsewhere. Circumstances varied with every locality.

Consequently, if a species be found in the roof shales of bed A, and not in those of bed B above it, it does not follow that the species had become extinct. It may have been growing in bed B elsewhere; and by the time bed C came into growth, the same species having returned to its old locality, by force of favorable circumstances, may have left its remains in the roof shales of bed C.

Only after a careful study of the whole extent of all three beds, and upon finding a species in one or more places in bed A, and not anywhere in beds B and C, can the probability of its extinction (or modification into another species) be even provisionally adopted.

Nothing can more plainly show how difficult a study this of the *vertical distribution* of plants is. A long time must yet pass, and extensive re-searches are still to be pursued, before sufficient data are collected for the elucidation of the problem. The coal fields are of immense extent; exposures are comparatively few and wide apart, and the roof shales of a very small number of mines have been examined.

§ 24. The *area* of the coal deposits of Carboniferous age, in the United States, is generally estimated at about 190,000 square miles, divided into six sub-areas or coal-fields as follows, beginning at the east:

a. The *Anthracite sub-area* includes: 1, Some small outlying basins in Rhode Island and Massachusetts; 2, The coal fields of the Schuylkill, the Lehigh and North-branch Susquehanna rivers in Eastern Pennsylvania. These are called the First, Second, and Third *Anthracite Coal Fields*, and are known locally as the Mauch Chunk, Tamaqua, Pottsville, Dauphin county, Wiconisco, Mine hill, Broad mountain, Mahanoy, Shamokin, Beaver meadows, Hazleton, Wilkes-Barre, Scranton, and Carbondale basins. The area of these three fields is about 1,000 square miles, and it is at present the most important coal area in the world, in view of the great thickness of the beds and the quality of their coal.

b. The *Appalachian* bituminous coal field of Western Pennsylvania, Eastern Ohio, Western Maryland, West Virginia, East Kentucky, East Tennessee, and North Alabama; with an area of nearly 48,000 square miles.

c. The *Illinois* bituminous coal field, occupying also the Western border of Indiana, and a part of Western Kentucky; with an estimated area of 47,200 square miles.

d. The *Iowa* bituminous coal field, occupying also portions of Missouri, Kansas, and Nebraska; with an estimated area of 52,650 square miles.

e. The *Michigan* bituminous coal basin; with an area of 6,700 square miles.

f. The *Western Arkansas* coal field, of about 10,000 square miles.

§ 25. The term *Carboniferous* is usually employed properly to designate the coal measures superior to the Pottsville conglomerate or Millstone grit of England, and their coal beds were formerly distinguished as bed A, bed B, etc., beginning at the top of the Conglomerate and lettering upwards. Local geographical names have been substituted for this lettering in Pennsylvania.

The term *Sub-Carboniferous* has been and is still used to designate all the workable coal beds subsequently discovered to exist either in the body of the Conglomerate or within a few hundred feet beneath it.

The term *Inter-conglomerate* coals is now frequently used for the beds in the body of the Conglomerate itself, since the discovery of the fact that the Conglomerate is not a solid mass, but divisible into a series of separate deposits of gravel, sand and clay.

Beneath the Pottsville Conglomerate in descending order lie the following formations: Mauch Chunk red shale (No. XI); Pocono sandstone (No. X); Catskill red sandstone (No. IX); Chemung, Portage, Marcellus, Hamilton, Genessee, Upper Helderberg (No. VIII), and Oriskany sandstone (No. VII), which last is adopted as the bottom formation of the Devonian system.

In several of these formations deposits of coal have been discovered much older than the true Carboniferous or Sub-carboniferous, but furnishing no coal beds of practical value except in one or two instances. In a work like this, however, it is important to consider these *earlier formations of coal*, on account of the peculiar vegetable forms which they contain; and this will now be done as preliminary to a statement of the true coal beds, and beginning with the lowest formation in which coal has been observed.

§ 26. It is needless to speak of the small concretionary pieces of coal which have been found in many places in the *Hudson River formation* (No. III) near the bottom of the Silurian system; because they are not in the form of coal beds; and have yielded no plants.

The earliest real coal beds have been observed in the *Marcellus*, near the base of the Portage; but-only in one locality, the region of the lower Juniata river in middle Pennsylvania. As yet no record of the plants which enter into their composition has been got, and therefore no account can be taken in this work of the botany of these Lower Devonian coal measures.

§ 27. From the *Catskill* group of rocks the only vegetable remains obtained by the explorations of the Pennsylvania Survey represent one species alone, *Archaeopteris minor*, communicated in numerous specimens by Mr. A. Sherwood from northern Pennsylvania. At a lower stage in the formation Mr. Sherwood found also numerous fragments of *Dictyophytum*; but the affinity of this plant is as yet uncertain, and its distribution in the column of rocks is generally ascribed not to the Catskill but to the Chemung.*

§ 28. For various reasons not necessary here to give in detail, the *base of the Sub-carboniferous*, and therefore the base of the entire system of Coal Measures, has been fixed at the dividing line between the top of the Catskill and the bottom of the Pocono formations; although in point of fact no such dividing line can be drawn with precision, because, in the absence of fossils for several hundred feet, no distinction can be made between the two formations except such as is founded on differences of lithological composition. For it so happens that there are alternations of these lithological characters in the beds belonging to the top of the one formation and the bottom of the other. Therefore, in the absence of any non-conformability, and in view of the evident continuation of the deposits, while it may be said that the Chemung formation graduates by alternations upwards into the Catskill, it is nevertheless true that *taken as a whole* the Chemung formation is perfectly distinguishable from the Catskill formation above it.

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* Professor James Hall, in the Seventh Annual Report to the State University of New York, describes with figures, pp. 87, etc., nine forms or species of *Dictyophytum*, from the Devonian of New York and Ohio. The fragments collected by Mr. Sherwood are small; the characters are not sufficiently defined to allow of an elaborate description. They represent small branches, divided, at right angles to the axis, into three or more branchlets inflated at top. This character is not remarked in the species described by Mr. Hall.

Another fact which makes the determination of the base of the Carboniferous at the base of the Pocono purely empirical is this, viz: The first coal beds met with (going up) are not at the base of the Pocono, but about two thirds of the way upwards towards the top. At this stage in the Pocono occurs the first important formation of coal.

There are, nevertheless, certain coarse conglomerate strata at the bottom of the Pocono, formed of large pebbles, which may be considered, perhaps, as the practical base of that formation, and over these are softer sandstone and shale deposits in which no kind of organic remains have yet been discovered.

§ 29. The *Pocono* (Vespertine) formation (No. X) is a group of rocks best described at one locality in Huntingdon county, Middle Pennsylvania, from data obtained in the gap of Sideling hill and in the railroad tunnel through that mountain at a higher level. This description will be found in Report F of the publications of the Second Geological Survey, pages 206 to 208.

The lower division of the Pocono is here a series of alternating shales, and massive and sometimes conglomeritic sandstones, with layers of red shale and of carbonaceous shale.

The middle division of the Pocono here contains numerous very thin coal beds, 19 of which are recorded by Mr. Ashburner in his section; but no one of these beds is more than about one foot thick.

In Perry county, Pennsylvania, at the junction of the Juniata and Susquehanna rivers, a coal bed has been opened in the Pocono sandstone (hundreds of feet beneath the Mauch Chunk red shale) which, with its roof shales, measures 4′. Probably other beds of less size accompany it.

On the borders of Virginia and West Virginia, at the Lewis tunnel of the Chesapeake and Ohio railway through the Allegheny mountain, near the White Sulphur springs, Prof. W. M. Fontaine found what seems to be the Pocono coal measures, 410 feet exposed, holding four or five coal beds, none of them a foot thick. The upper 135′ has a local coal bed resting on coarse sandstones. The next 215′ contains four coal beds, and rests upon a 60′ mass of white, pebbly sandstone. Under these come 500 feet of flags and shales; and these the red marls and shales of the Catskill, No. IX.*

In southern Virginia, on the New river in Montgomery county, and near Augusta, in Augusta county, Prof. W. B. Rogers, the State Geologist of Va., reported, in 1836, workable coal beds far below the Conglomerate. In 1858 Prof. J. P. Lesley described in the Proceedings of the American Philosophical Society, two beds of coal on Tom's creek, Montgomery county, 4′ and 8′ thick, respectively, in a shale formation overlying the Pocono sandstone, and underlying 1000′ of Mauch Chunk red shales; and in the Peak mountain of Wythe county a dozen small coal beds enclosed in the Pocono sandstones.—In 1877, Prof. W. M. Fontaine described in Silliman's Journal a section made at the Lewis tunnel, on the Chesapeake and Ohio railroad, through the Allegheny mountain, where four coal beds, all less than 1′ thick, inhabit 215′ of measures enclosed between a top conglomerate of 95′ and a bottom conglomerate of 60′, under which lie 500′ of flaggy sandstones and shales; these again lying on Catskill red marls and sandstones.

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*See Silliman's Journal for Jan., Feb., 1877; and Ashburner's Report F, page 214, 215.

In the coal measures of the west, the *Pocono* formation has not been recognized; or, if it exists, is composed merely of limestone strata. Thus in Illinois the *Kinderhook* group, about 100 feet thick, and mostly limestone, is probably referable to the Pocono; although some geologists consider it Chemung.

§ 30. The *Mauch Chunk*, (Umbral,) red shale formation No. XI, lies upon the Pocono, and under the Pottsville Conglomerate. It varies greatly in thickness and composition, exhibiting several thousand feet of red shale in Eastern Pennsylvania, fining down to almost nothing in Western Pennsylvania, and becoming a great limestone formation in the southern and western States. I use the term Sub-conglomerate to designate the forms found in this formation.

In Middle Pennsylvania the section given by Mr. Ashburner, in Report F, represents it as 1,100 feet thick, divisible into three members: 1, The upper, composed of shales and sandstone, 910 feet thick; 2, The middle (Mountain limestone,) 49 feet thick; and, 3, The lower, composed of shales and sandstone, 141 feet thick, without coal beds in either of the divisions.

In Maryland the red shale is not only repeated and the limestone also, but the whole formation compares in total thickness to that of its normal exhibition on the Schuylkill and Lehigh rivers in eastern Pennsylvania. According to Mr. Howard G. Jones' section (1874 to 1880) it consists (at the top) of 200′ of gray shales, 375′ of red shale, 360′ of limestones, 2000′ of red shales, 475′ of limestones, and (at the bottom) 300′ of gray shales (holding iron ores) immediately above the top of the Pocono, which consists of 100′ of very massive white sandrock. The total thickness of Mauch Chunk here is either 3410′ or 3710′. Both the limestone divisions are very fossiliferous in their higher layers.

In West Virginia, Professor Fontaine combines in his section of 1,197 feet of rock the Mauch Chunk, with the

Conglomerate above it,* and calls the whole group the *Conglomerate series*, consisting of shales, corrugated sandstone, massive sandstone, and a bed of ferruginous limestone, and in the middle of the group nine coal beds. The Upper coal bed (Quinimont) is 4 feet thick. The lowest of the coal beds is *reported* to be 11 feet thick, but this was not seen by Professor Fontaine. The other coal beds vary from 8 inches to 10 feet. At the top of the section lies a Conglomerate sandstone 150 to 200 feet thick, and at the base of the section lies another Conglomerate 80 feet thick. Hence the terms *Conglomerate* and *Inter-Conglomerate series.*

In Alabama, the Warrior Coal basin of Jefferson county exhibits a section which seems to correspond with that of Professor Fontaine, in West Virginia.

At the base lies 100 feet of silicious sandstone, resting on shales, limestone with *Pentremites* and sandstones, in all 210 feet thick; at the top of the section is a conglomerate 16 to 20 feet thick. The interval of 729 feet between these two conglomerates is filled up with alternations of coal, shale, clay, and sandstone, and in this interval (of 729 feet) lie 13 coal beds, varying in thickness from 1 to 3 feet, and measuring altogether 25 feet of coal.

In Tennessee, the Sub-Conglomerate measures resting on Mountain limestone, are divided into two parts. The lower, 228 feet thick, contains three thin coal beds (one four feet thick)† alternating with shales, clay and sandstone; and the top of this lower member is a conglomerate sandstone 70 feet thick. The upper part, over this conglomerate, is from 300 to 500 feet thick, and is capped by another conglomerate of 50 feet. In this interval (300 to 500 feet) lie four coal beds, one only workable, the Sewanee, varying from 3 to 7 feet in thickness.‡

Whether the whole section represents Sub-conglomerate measures, is the question which will be examined in considering the character of the plants found with these coal beds.

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* American Journal of Science, third series, vol. IX, p. 279 and 280.

† The Etna vein under the conglomerate and cliff rock in the Raccoon mountains, is 3 feet thick, and the most important coal seam of the section. See Geological Report of Tennessee, James Safford, p. 369.

‡ The section (*ibid.*, p. 389) shows approximately 500 feet of measures, including a heavy top sandstone 100 feet thick.

In Arkansas, all the Coal measures underlie a conglomerate formation, which varies in thickness from 40 to more than 1000 feet. The *Wilmoth* coal seam, in Johnson county, is overlaid by 1100 feet of measures, dark yellow-reddish shale, thin-bedded flaggy sandstone, passing upwards into a massive sandstone (sub-divided into three members) from 500 to 600 feet thick. The *Spadra* coal, also in Johnson county, is a semi-anthracite coal, remarkably rich in fixed carbon (86 per cent.) and like the Wilmoth coal, is covered by 90 feet of black shale under a conglomerate.

In Missouri, the Sub-conglomerate measures, as also the conglomerate strata, are not distinctly defined from the underlying *Mountain limestone* (Chester, Saint Louis) group. The only remark I find of this formation, is in the Geological Report of Missouri, 1872, p. 279, where, in the description of Lincoln county, is noticed the occurrence of a coal bed of limited area, or coal in isolated masses, lying in depressions, or previously excavated holes, in the sub-carboniferous limestone.

No fossil plants have been received from the Sub-conglomerate strata of Missouri. In Henry county, *Taonurus Colletti* abounds in the drab shaly sandstone indicated in the report as Lower Carboniferous.

In the Northern coal areas, the Sub-conglomerate coal measures are distinctly and definitely separated from the underlying formations, and generally hold workable coal beds.

The lower division consists, usually, of heavy beds of limestone and sandstone. The *Chester* and *St. Louis* (Archimedes, Pentremites, Mountain) limestone groups of Illinois, Indiana, and Kentucky, come in here. The sandstones, which in many places alternate with the limestones and shales in the lower part of the formation, constitute in Kentucky the Knob sandstone series,* (Pocono, No. X. ?)

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*The designation was first employed in D. D. Owen's Geol. Rt. of Kentucky, I, p. 90, 1856, to characterize the rocks of ranges of conical hills fronting the last outcrop of the Coal Measures, and was afterwards used throughout his reports.

The upper division, between the Chester limestone and the Conglomerate, consists of shale beds holding workable coal beds.

In western Kentucky, the lower division, 200 to 500 feet thick, supports shales with one or two workable coal beds. In Breckenridge county two thin coal beds (six to ten inches) are intercalated between the Archimedes limestones. (Geol. Rep. Ky., II, p. 88, and III, p. 328.)

In eastern Kentucky, the lower division consists of from 5 to 50 feet of Knob-stone. and from 70 to 400 feet of limestone; above which, in the upper (shale) division, come from one to five coal beds, varying from one to five feet in thickness. (Geol. Rt. Ky., IV, p. 451.)

In Illinois, the lower division is mostly limestone, the Chester and St. Louis groups together being nearly 1000 feet thick. The upper shale division holds sometimes one coal bed, three or four feet thick, close under the Conglomerate. There is also a thin coal bed underneath the Chester and above the St. Louis group.

In Indiana, the sub-carboniferous is a diversified formation of 1, a soft black shale; 2, an upper limestone (*Kaskaskia*); 3, black shale; 4, *Chester* limestone (sometimes sandstone), and 5, *St. Louis* limestone (200 to 400 feet thick) lying at the bottom of the group.

Here, as in Illinois, a coal bed usually appears with the first black shale just under the Conglomerate; and another between the Chester and the St. Louis groups.

From these sub-conglomerate measures in Indiana and Illinois we have no vegetable remains; but a number of fine plants are described from a clay bed underlying the Chester group in Illinois; and also from the whetstone beds which in Indiana replace the Chester limestone beds of Illinois.

In southern Ohio the Waverly group. 350 feet thick, and in northern Ohio the Cuyahoga shale and Berea grit 400 to 500 feet thick, have some fossil characters which would identify them with the sub-conglomerate series in Indiana; and their geological horizons have been followed through north-western Pennsylvania.

§ 31. The *Pottsville Conglomerate group* (No. XII) is a term adopted in Pennsylvania to designate a thousand feet of coarse sand deposits, the mountain outcrop of which marks the southern limit of the First Anthracite coal field. It is analogous to the English term Millstone grit.

This deposit, underlying the so-called Lower Productive Coal measures, and outcropping with steep dips around all the separate basins of the great Anthracite Coal area, diminishes in thickness rapidly in a north-west and west direction from Pottsville ; becoming only 250 feet thick at the west end of the Shamokin basin ; less than 200 feet thick about Wilkes-Barre, Scranton and Carbondale ; and not thicker in middle Pennsylvania around the Broad Top semi-bituminous coal basin, and in Maryland around the Cumberland semi-bituminous coal basin.

This progressive diminution in the thickness of the formation was supposed, until recently, to go on northward and westward throughout the bituminous coal area spreading west of the Allegheny mountain ; for it seems to be less than one hundred feet thick at Towanda and Blossburg, and in western Pennsylvania.

But it is now known that this impression was erroneous. What was taken for the whole formation is in fact only the lower division of it. The whole mass is now subdivided into three great sandrocks,* separated by shales holding carbonaceous slates and coal beds.

Even around the Pottsville anthracite field large and important coal beds have been opened in the body of the Conglomerate ; and at Shamokin, where the whole is 250 feet thick, four coal beds are intercalated between five conglomerate sandrock subdivisions of it.

The thickness of the Conglomerate series (No. XII is now known to be maintained beneath the whole Bituminous Coal area of western Pennsylvania, at an average of 250 or 300 feet ; and the apparently great local variations in the thickness is due to the great sudden local variations in the composition of its three (or more) sand divisions.

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* Named in the northern counties, Pa., Upper : Johnson run rock ; Middle : Kinzua creek rock ; Lower : Olean Conglomerate. (See Report of Progress R, by Mr. C. A. Ashburner.) Named in the Western counties, Pa., Homewood sandstone ; Connoquenessing sandstone ; and Sharon Conglomerate. (See Reports of Progress Q^2 Q^3, by Prof. I. C. White.) Identical in Ohio with the Massilon Conglomerate group. (See Reports of Ohio, by Dr. Newberry.)

What has been said in preceding pages respecting the sub-conglomerate rocks of the western and southern States, must be understood to be provisional, inasmuch as no sufficiently close and thorough connection has yet been possible between the definitely limited series in Pennsylvania, and in those States. It is as yet impossible to say with certainty that any individual sandrock beneath the Coal Measures proper in W. Virginia, southern Ohio or Kentucky, is the precise analogue of the top, middle or bottom members of the Pottsville group in Pennsylvania ; even if it may not prove on examination to be lower than any of them in the series ; that is, perhaps an intercalated sand deposit of Mauch Chunk (XI) age.

As the greater number of fossil plants described in this report have come from the mines of Pennsylvania, the uncertainties just alluded to will affect but little the botanical conclusions arrived at as to the *vertical distribution of forms.**

In Western Maryland Mr. Howard Grant Jones' section † across the Cumberland coal basin, shows the conglomerate series to be there 560′ thick, from the top of the Piedmont sandstone to the lowest coal bed. Its coal beds are all thin, although one of them is locally workable, but variable.

In the west, as in the south, our knowledge of the constitution and contents of any series of massive sandstones which may be proved hereafter to be strictly cotemporaneous with the Appalachian Conglomerate (XII) is very insufficient. The so-called Conglomerate is variable and rarely described with sufficient minuteness, or traced continuously from one distant locality to another.

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*The reader will appreciate the force of this, by examining *Index B, of habitats*, and the specially long lists of genera and species there referred to under the heads of "Pittston," and "Cannelton."

† Constructed in 1874, studied anew in the following years, and finished in 1880. See Report H^3 on Somerset and Cambria counties. F. &. W. G. Platt, 1877. See also the proceedings of the American Philosophical Society, Philadelphia, September 17, 1880.

In parts of Illinois, especially Morris, Colchester, Murphysborough, etc., on the northern boundary of the field, the Conglomerate is reduced to a single bed scarcely 6 feet thick; but on outlying patches further north it frequently occurs from 20 to 110 feet thick.

In Indiana, also, the Conglomerate is said to vary in thickness from 20 to 100 feet.

In Western Kentucky the Conglomerate is found divided into two members. Under the main mass of conglomerate, and separated from it by a few feet of shales, is a lower stratum of the same composition; and in the interval between the two occurs a bed of coal, as on the Ohio river near Caseyville, (see description of the Battery Rock coal, in the Kentucky reports.)

In Eastern Kentucky, as in Ohio and Pennsylvania, the Conglomerate is still more varied in composition, and undergoes, locally, great changes of thickness; but it is generally in two beds of different characters, both of them variable; so that it is still questionable whether coal beds like the Jackson coal and the Cuyahoga coal of Ohio, should be considered Sub-conglomerate or Inter-conglomerate coals. A similar question, respecting the Sharon coal of Pennsylvania, has been recently settled with some certainty by the surveys of that State, and that coal bed placed systematically *in* the Conglomerate, and not *under* it.

The only coal beds evidently within the body of the Conglomerate which I have myself seen are the Battery Rock bed in Illinois, above mentioned, and a bed on Mill creek above St. Clair, in the Anthracite basin of Pottsville; but from these beds I have not obtained any valuable materials to represent their flora.

On the North Branch of the Susquehanna, however, in Eastern Pennsylvania, a bed of shale, without coal, but rich in fossil vegetable remains, occurs at Campbell's Ledge above Pittston, between two massive plates of the Conglomerate, the interval being only from 6 to 8 feet.

Whether or not some of the coal strata called Sub-conglomerate, in this report, and from which fossil plants have been obtained, be, or may be Inter-conglomerate coal beds, is a question which shall be examined on the basis of data exhibited in the table of distribution further on.

§ 32. The *Carboniferous proper* or *Productive Coal Measures*, are represented in the Anthracite Fields of Pennsylvania, by about 1,400 feet of strata containing (where the coal beds have been most mined) from 12 to 14 coal beds, variable in thickness individually, but averaging at least 100 feet of combustible material.

The section at Scranton, in the Third Anthracite Coal Field, given in Lesley's Coal Manual of 1856, shows 14 coal beds in about 800 feet of measures.

A generalised section published by Messrs. Daddow and Bannan, (Coal, Iron and Oil, p. 247,) gives 14 coal beds, with thicknesses varying from 2 to 15 feet, and footing up 110 feet of coal, in 1,530 feet of measures, measured from the top of the Conglomerate upwards.

The same number of beds and about the same amount of coal (107 feet) is given by Mr. P. W. Sheafer in his memoir "On the Anthracite Coal Fields of Pennsylvania, and their exhaustion."

A section derived from a boring on Judge Woodward's lands, in Upper Plymouth, Luzerne county, Pennsylvania, shows 949 feet of measures, enclosing 7 coal beds from 5 to 29 feet thick, with 91 feet of coal. This section lacks the higher measures.

§ 33. The plants known through the Anthracite region are numerous enough. But except for the Pittston section few positive data have been obtained relative to the horizons at which the vegetable remains have been obtained. The Mammoth vein, about the fourth above the Conglomerate, and the Salem or Gate vein high up in the mensures are exceptions.

The numerous plants from the Anthracite of Rhode Island are interesting in regard to the geographical distribution of the forms; but as yet the horizon of the Rhode Island coals is not positively made out.

§ 34. The Bituminous coal measures of Pennsylvania are sub-divided thus:

1. *The Lower Productive Coal Measures*, which com-

mence at the top of the Conglomerate, and ascend to the Freeport Upper coal bed under the Mahoning sandstone. This division is between 300 and 400 feet thick, and includes 9 or 10 coal beds, 5 of which are usually of workable size, but not all in any one locality.

2. The *Lower Barren Measures* ascend from the Mahoning sandstone to the Pittsburgh coal bed, and are about 600 feet thick, including 6 or 7 coal beds, or continuous deposits of coaly matter, usually very thin and impure, but widely traceable through the bituminous coal fields; as are also the intermediate characteristic beds of limestone, red shale and sandstone intercalated among them. In Somerset county, Pennsylvania, however, several of the Barren Measure coal beds are workable, and in some instances are large and important.

3. The *Upper Productive Coal Measures* ascend from the Pittsburgh coal bed. 400 to 500 feet, to the Waynesburg sandstone, and contain 5 coal beds (including the Pittsburgh at the bottom,) varying from 1 to 15 feet in thickness. In this division occur the great limestone formations of the Upper Coal Measures.

4. The *Upper Barren Measures*, over the Waynesburg sandstone, have been divided by Professor J. J. Stevenson (see Report K, page 34, 1876,) into two groups: (*a*,) *Washington County Group*, from the Waynesburg sandstone up to the Washington limestone, a distance varying from 150 to 450 feet; and, (*b*,) The *Green County Group*, from the Upper Washington limestone to the highest strata left by erosion on the upland surface of southwestern Pennsylvania, with an extreme thickness of about 800 feet.

§ 35. The *Permo-carboniferous* formation of south-western Pennsylvania and West Virginia.

The recent discoveries by Profs. Fontaine and White of numerous Permian plant-forms in the Upper Barren Measures have been published in Report of Progress PP. (See especially page 117.)

It becomes probable that the Waynesburg sandstone is the analogue of the conglomerate base of the Permian system in other parts of the world; that the red shales higher up represent the red measures of the Permian; and that the numerous beds of limestone in the Green county and Washington county groups represent to an uncertain extent the Zechstein of Europe.

§ 36. In southern Virginia Prof. J. J. Stevenson finds in a total thickness of 1751′—80′=1671′ above the top of the Conglomerate 18 coal beds, varying from 4 inches to 15 feet in thickness. The aggregate thickness of coal in the upper seven beds is only 6′ 5″; in the lower ten beds 47′ 3″.* The 15′ bed is the fifth from the bottom.

He supposes it possible that the lower 883′ of this section may correspond to the Lower Productive coal measures of Pennsylvania, since this division increases southward through West Virginia, from about 350′ on the Pennsylvania state line to more than 700′ on the Baltimore and Ohio railway, and to more than 1200′ on the Great Kanawha river,† where the upper limit is fixed by the "Flint Ledge" connected with the Mahoning sandstone.

In Tennessee, west of Knoxville, Prof. Lesley's unpublished sections, from the lowest coal bed at the mouth of Coal run (on a level with the lowest drainage of the country) to the tops of the highest mountains, capped with Conglomerate sand rocks, amounted to more than 3000 feet.

§ 37. In Ohio the distribution of plant-forms throughout the *Productive Coal Measures* is very much the same as in Pennsylvania, with the same amount of local variations.

A generalized section of 1100 feet of Coal Measures, given by Dr. Newberry in the Geol. of Ohio, Vol. II, p. 81, extends from the top of the Conglomerate to 350 feet above the Pittsburgh coal bed, and contains 13 well defined coal beds, five of which above the Pittsburgh bed are scarcely thick enough to be considered workable.

Few plant remains have been obtained or described from the Ohio Coal Measures except those described by Dr. Newberry from the Conglomerate coal of Cuyahaga and the coal of Youngstown on the Ohio river near the Pennsylvania state line; and those described by Prof. E. B. Andrews from a shale of the Sub-carboniferous Waverly group. We have only a few species from the Pittsburgh bed at Pomeroy on the Ohio river, and from St. Clairsville.

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*Two of these beds, however, could not be measured, as only the blossom was visible. For this section see Proc. Amer. Philosoph. Soc., Philadelphia, Aug. 1880.

†See Proc. A. P. S., Notes on the Geology of West Virginia, No. 2, 1876.

Over eastern Kentucky extend the Ohio coal measures, with a similar distribution and variation of plant forms, very few of which, however, are known.

In Illinois the Coal Measures proper are about 1000 feet thick, and include 16 coal beds, the lower seven of which are locally variable in thickness from 2 to 7 feet. The higher beds vary in thickness from 6 inches to 2 feet. (See Geol. Rept. Illinois, 1875, Vol. VI, pp. 2 to 5.)

The lowest (Morris) coal of Illinois, lying generally close above the Conglomerate, is the one worked and exposed at the borders of the field; and the largest number of plant-forms known in that region have been collected from its roof shales. Many of them have been found in calcareous concretions enclosed in these roof shales, on Mazon creek, at Murpheysborough, and elsewhere.

In western Kentucky, the coal measures of which are an extension of the Illinois field southward across the Ohio river, and similarly constituted, the plants are little known.

In Indiana, the Coal Measures proper, forming the eastern border of the Illinois field, are described in a general section, in the Report to the State Board of Agriculture for 1876. Here 650 feet of measures contain 12 beds of coal, from none of which have we received any plants, with the exception of some fruits from the Conglomerate itself. The vegetable remains mentioned in this report come from the Sub-carboniferous whetstone rocks.*

In Missouri, Professor J. C. Brodhead, in his Geological Report for 1879, vol. 2, p. 53, gives a condensed vertical section of the coal measures thus sub-divided:

1. Upper coal measures 1319 feet thick, with 3 coal beds, neither of which is more than 1 foot thick.

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*I have recently seen some beautiful specimens, from the coal of Sullivan county, sent to the National Museum at Washington, by Mr. J. W. Spencer, of Paxton, in that county. This coal is N. 6 of the Indiana Geol. Reports.

2. Middle coal measures 290 feet thick, with 5 beds of coal, the thickest being 2 feet, and the aggregate of the 5 measuring only 5′ 7″ of fuel.

3. Lower coal measures 269 feet thick, with 8 coal beds, varying from 5 inches to 4½ feet, and aggregating between 11 and 12 feet of coal.

Most of the plants obtained from the Missouri field were got near the roof shales of the Clinton coal, the third from the bottom.

From Michigan, no fossil plants worth mentioning have been obtained. The numerous specimens sent in by the State Geologist, Dr. Roeminger, all represent the omnipresent *Stigmaria ficoides*, of the under clays.

§ 38. *The table of vertical distribution* now to be presented is arranged in separate columns, thus:

I. PRE-CARBONIFEROUS.

Column 1.

D.	Devonian.
Ch.	Chemung (top division of No. VIII)=middle Devonian.
Ca.	Catskill (No. IX,) upper Devonian.

Column 2. Pocono sandstone (No. X.)

In Penn'a, Sideling Hill tunnel, Huntingdon county, (S.); Red shale, below Pottsville (Mt. Carbon) (Po.); Lehigh Gap, below Mauch Chunk (M.); Banks of the Susquehanna, above Pittston (Pi.); (Lewis Tunnel, (L.) and New River Group, (N. R.,)? W. Virginia.)

Column 3. Sub-conglomerate; Mauch Chunk No. XI.? *

W. Va.	Plants quoted from Fontaine's conglomerate series of W. Virginia.
Al.	Alabama.
Te.	Tennessee.
Ar.	Arkansas.
Ill.	Illinois; Chester group.
In.	Indiana; Chester group.
M.	*Megalopteris* beds of Ohio and Illinois, in a half column.

Column 4. Inter-conglomerate, No. XII.

Ca.	Campbell's Ledge, near Pittston, E. Pennsylvania.
S.	Shamokin Gap, E. Pennsylvania.
J.	Jackson Shaft bed, Ohio.
Cu.	Cuyahaga bed, Talmadge, Summit beds, Ohio.
Y.	Youngstown, Ohio.

II. COAL MEASURES PROPER.

1. *Anthracite Fields.*

Column 5.

Beds, A, B and C, at Archibald, Carbondale, Pittston and vicinity. In Ontario, Carbon Hill shaft, Boston, Everhart, and other collieries. These beds are often close together or united.

Column 6.

Beds D, E, F, at Pittston, Wilkesbarre, Scranton, Plymouth, and vicinity. At Butler, Tompkin's, Pennsylvania Coal Company's, Port Griffith, Brown collieries, Carbon Hill Tunnel collieries, with Baltimore or Mammoth vein of Wilkesbarre. These beds are also quite close, and sometimes together.

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* The plants are not separated by their local habitats, but only by the names of the States in which their habitats lie; as they are not sufficiently known from local sections. They may define geological groups like those in the following columns. The relation of the Penn'a XI to the sub-conglomerate of the other States is not definite.

Column 7.

Bed 1, Go, of the Oliphant section; G, at Oakwood, Plymouth; Wilkes-Barre, &c.

Column 8.

Upper anthracite (Salem and Gate veins, Tunnel vein of Tremont, &c.)

Column 9.

Rhode Island coals, and others the horizons of which are not yet determined.

2. *Bituminous Fields.*

Column 10.

Coal A, B above the Conglomerate, (both beds often united.)

Mu.	at Murphysborough,	Illinois.
N.	at Nelcysville,	
Ma.	at Marseilles,	
Co.	at Colchester,	
Mo.	at Morris,	
Ma.	at Mazon Creek,	
Ca.	at Centralia shaft.	
Va.	at Vandalia.	
Ky.	at Burnt branch of Caney, etc., Kentucky.	
Ma.	at Massillon, Ohio.	

Column 11.

Coal C, (which is sometimes united to B.)

Cl.	at Clinton, Missouri.
Ca.	at Cannelton, West Pennsylvania.

Column 12.

Fourth Coal (under the Barren Measures.)

D.	at Duquoin,	Illinois.
St.	at St. John,	
N.	at Nelsonville, Ohio.	
Co.	at Coshocton, Ohio.	
In.	at Sullivan Co., Indiana.	

Column 13.

Upper coal, (top of the Barren Measures.)

Pi.	at Pittsburgh, in Pennsylvania.	
Po.	at Pomeroy,	in Ohio.
S. C.	at St. Clairsville,	
B.	at Barnsville,	
C.	at Carmi Illinois.	
In.	at Grayville and New Harmony, Indiana.	

Column 14.

Coal beds of undermined horizons.

Column 15.

Coal plants also found in Europe.

Table of distribution of the plants

Page.	NAMES OF SPECIES.	PRE CARBONIFEROUS.				
		Devonian. Chemung. Catskill.	Pocono.	Mauch Chunk red shale or sub-conglomerate.	Intra conglomerate. Bituminous.	Anthracite.
1	CRYPTOGAMOUS,					
1	FUNGI,					
3	*Rhizomorpha*,					
3	R. Sigillariæ,					
4	THALASSOPHYTES.					
6	*Taonurus*,					
7	T. marginatus,				○	
7	T. Colletti,					
8	T. Cauda-Galli,	○		○		
9	*Palæophycus*,					
10	P. Milleri,					
11	P. gracilis,					
11	P. divaricatus,					
12	*Asterphycus*,					
12	A. Coxii,					
13	A. simplex,					
14	*Conostychus*,					
15	C. Broadheadi,			Ar., Mo.,		
16	C. prolifer,					
17	C. ornatus,				○	
17	CALAMARIÆ,					
19	*Calamites*,					
20	C. Suckowii,					
21	C. major,					
22	C. ramosus,					Ca.,
23	C. ramifer,			W. Va. ?		Ca.,
24	C. cannæformis,			W. Va.,		
25	C. gigas,					
26	C. approximatus,			Ar., Al., W. Va.,		
27	C. Cistii,					
27	C. dubius,					
28	C. pachyderma,				Ky.,	
29	C. disjunctus,					
29	C. gracilis,					
30	*Bornia*,					
30	B. radiata,	Dev.,		Ar., Ala., W. Va.,		Ca.,
32	*Calamodendron ?* species,					
34	*Asterophyllites*,					
35	A. equisetiformis,	✓	—			
36	A. anthracinus,					
36	A. longifolius,					Ca.,
37	A. rigidus,					
38	A. sublævis,					
38	A. foliosus,					Ca.,
41	A. grandis,					
41	A. fasciculatus,					
42	A. gracilis,			Al., Ar.,		
44	*Annularia*,					
45	A. longifolia,					
47	A. inflata,					
48	A. calamitoides,					

described in the U. S. Coal Flora.

TRUE CARBONIFEROUS.

ANTHRACITE.					BITUMINOUS.							
A, B, C.	D, E, F.	Go, G	M		A, B.	C.	D, E, F.	G.				
Archbald, etc Carbondale, etc. Pittston, etc.	Pittston and vicinity. Wilkes-Barre and vicinity. Plymouth and vicinity. Scranton and vicinity	Olyphant, No. 1. Wilkes-Barre.	Upper strata, Salem. etc.	Rhode Island and undetermined stations.	Mazon Creek. Murphysborough. Colchester, etc.	Canelton. Clinton, etc.	St. John. Duquoin. Indiana.	Pittsburgh. Helansville. Pomroy.	Stations undetermined.	Species found in Europe.	Page.
											1
											1
											3
						Ca.,					3
											6
											7
								○			7
									○		8
											9
								○			10
								○			11
								○			11
											12
								○			12
					—						13
											14
											15
											16
											17
											17
											19
—					—					○	20
					Ma.,					○	21
—					—					○	22
						Ca.,				○	23
—					—					○	24
								○		○	25
—										○	26
—					Ma.,					○	27
	E,	Go,								○	27
										○	28
			M,			Ca.,					29
									○		29
											30
C,										○	30
						Ca.,		○	○		32
											34
—					—					○	35
						Ca.,				○	36
	E,				Ma., Mo.,		In.,			○	36
	E,				Ma., Mo.,	Ca.,				○	37
				R. I.	Ma.,	Ca.,					38
B,			M,		Ma.,					○	38
				R. I.	Mo.,	Ca.,				○	41
						Cl.,					41
											42
											44
—					—						45
	E,	Go,			Ma.,	Ca.,					47
					Ma.,						48

	Annularia.					
48	A. sphenophylloides,					
49	A. minuta,					
50	A. radiata,			T.,		
50	A. Emersoni,					
51	A. Dawsoni,			Ala.,		
51	*Sphenophyllum,*					
52	S. Schlotheimii,			Ar.,		
53	S. emarginatum,					
53	S. longifolium,			Ar.,		
55	S. erosum,					
55	S. bifurcatum,			Ar.,		
56	S. cornutum,					
57	S. oblongifolium,					
58	S. filiculme,					
59	*Calamostachys,*					
59	C. prælongus,					
60	*Macrostachya,*					
60	M. infundibuliformis,					
62	*Equisetites,*					
62	E. occidentalis,					
63	*Trochophyllum,*					
64	T. lineare,			O.,		
65	T. clavatum,					
65	*Filicaceæ,*					
73	NEUROPTERIDÆ,					
75	*Neuropteris,*					
77	*Cyclopterids,*					
77	N. reniformis,			Ala.,		
78	N. dilatata,					
79	N. trichomanoides,					
80	N. laciniata,					
	Nephropterids.					
81	N. fimbriata,			Ar.,		
82	N. dentata,					
83	N. Rogersi,					
84	N. gibbosa,					
85	N. auriculata?					
86	N. inflata,			Ala.,		
87	N. Collinsii,					
	Euneuropterids.					
88	N. hirsuta,			Ar.,		
89	N. angustifolia,					
91	N. cordata,					
93	N. decipiens,					
93	N. fasciculata,					
94	N. Clarksoni,					
96	N. plicata,					
97	N. rotundifolia?					
98	N. Loschii,					
99	N. vermicularis,					
100	N. tenuifolia,		N. R.,	Ar., W. Va.,		
102	N. subfalcata,			Al.,		
103	N. capitata,					
104	N. Missouriensis,					
105	N. Grangeri,					
	Pachydermatæ.					
106	N. Smithsii,			Ala., W. Va.,		
107	N. Elrodi,			Ala., In.,		
108	N. obscura,					
109	N. rarinervis,					
111	N. coriacea,					
112	N. Desorii,					
113	N. Germari,			Ill.,		
115	N. callosa,					
116	N. crenulata, ?					
117	N. Evenii,					
117	N. Agassizi,					
	Anomalous.					
119	N. anomala,					
120	N. verbenæfolia,					
121	N. biformis,			Ala.,		
121	N. aspera,					
122	N. fissa,					
123	N. minor,					
123	N. acuminata,					
124	*Odontopteris,*					
125	O. tenuinervis,					
126	O. Alpina,					

—					—						48
			M,							○	49
										○	50
								St.,			50
											51
											51
—					—					○	52
	E,		M,	R. I.	Ma., Mo.,		D,			○	53
	E,	Go,			Ma.,	Ca., Cl.,		B.,		○	53
								St.,		○	55
											55
					Co., Mo.,						56
						Cl.,				○	57
—			M,	R. I.	Ma.,	Cl.,					58
											59
C,											59
											60
B,		Go,			Ma.,	Ca.,				○	60
											62
					Ma.,	Ca.,					62
											63
											64
		Go,						Pi.,			65
											65
											73
											75
										○	77
						Cl.,				○	78
			M,			Ca.,				○	79
				○							80
	E,	Go,	M,		Mo., Ma ,	Ca.,		B., St.,			81
	E,		M,								82
			M,			Ca.,					83
			M,			Ca.,					84
						Ca.,				○	85
		Go,			Ma.,						86
					Ma., Mo.,						87
—			M,		Ma., Mo.,	Ca.,		Pi.,			88
—			M,		Ma.,	Ca., Cl.,				○	89
	E,		M,		Mo.,	Ca., Cl.,				○	91
					Ma., Ill.,						93
	F,				Ma., N.,						93
	E,	Go,			Ma.,	Ca.,	In.,				94
	E,				Ma.,	Ca.,		Pi., Po.,		○	96
			M,		○	Ca.,		Gr.,		○	97
—					Ma.,	Ca., Cl.,				○	98
		Go,			Ma., Ky.,	Ca.,					99
—				R. I.	—					○	100
											102
	E,				Ma., Mo.,						103
						Cl.,					104
	D ?		M,			Ca.,				○	105
											106
											107
			M,					St.,			108
	E,	Go,			Mo., Ma.,	Cl.,					109
					Ma.,						111
B,	D,		M,			Ca.,	In.,				112
			M,		Ma.,					○	113
			M,		Mo.,						115
		G ?	M,			Ca.,		Po.,		○	116
					Ma.,						117
				R. I.,		Ca., ?					117
			M,		Mo.,			St.,			119
					Ma.,						120
											121
					Mu.,	Ca.,					121
			M,								122
				○							123
				○						○	123
											124
			M,								125
		Go,		R. I.,						○	126

	Odontopteris.					
127	O. Newberryi,			W. Va.,	Y., Cu.,	
128	O. cornuta,					
129	O. heterophylla,					
130	O. Worthenii,					
131	O. alata,					
132	O. Brardii,			Ar.,		
133	O. squamosa,					
134	O. subcuneata,					
135	O. æqualis,					
136	O. Schlotheimii,					
137	O. subcrenulata,					
138	O. abbreviata,					
139	O. sphenopteroides,					
140	O. gracillima,			W. Va.,	Y.,	
140	O. Brardleyi,					
141	O. deformata,					
142	*Lesleya,*					
142	L. grandis,			Ill.,		
143	*Dictyopteris,*					
145	D. rubella,					
146	D. obliqua, *			Ar.,		
147	*Megalopteris,*					
148	M. Southwellii,			M.,		
149	M. Hartii,			W. Va., M.,		
149	M. minima,			M.,		
149	M. ovata,			M.,		
150	M. fasciculata,			M.,		
151	M. abbreviata,			Ill.,		
151	M. lata,			M.,		
152	M. marginata,			M.,		
153	*Tæniopteris,*					
153	T. Smithii,			Ala.,		
154	*Neriopteris,*					
154	N. lanceolata,				Cu.,	
155	*Orthogoniopteris,*					
156	O. clara,			M.,		
156	O. Gilberti,			M.,		
156	*Danæites,*					
157	D. Emersoni,					
158	D. macrophyllus,				Y.,	
159	*Idiophyllum,*					
160	I. rotundifolium,					
	ALETHOPTERIDS,					
162	*Lescuropteris,*					
162	L. Moorii,					
163	L. adiantites,					
164	*Callipteridium,*					
164	C. Sullivantii,					
166	C. Mansfieldi,					
166	C. Neuropteroides,					
167	C. Owenii,			Ar.,		
168	C. inæquale,					
169	C. Pardeei,					
169	C. rugosum,			Wa.,		
171	C. Aldrichi,			Ala.,		
172	C. membranaceum,					
173	C. Massilioucum,					
174	C. inflatum,					
175	*Alethopteris,*					
176	A. Serlii,					Ca.,
177	A. lonchitica,					
179	A. grandifolia,			W. Va.,	Cu.,	
179	A. Helenæ,		N. R.,	Wa., Ar., Ala., Ill.,	I.,	
181	A. Pennsylvanica,					
181	A. aquilina,					
182	A. ambigua,					
183	A. Gibsoni,					
185	A. Bunburyi,			M.,		
186	A. falcata,					
186	A. marginata,					
187	A. maxima,			M.,		
188	*Protoblechnum,*					
188	P. Holdeni,			M.,		

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* Dictyopteris Neuropteroides, Gutb. Top of a pinna, triangular; leaflets crowded, basilar lobe being rarely prolonged; terminal pinnule deltoid, enlarged on the side, very distinct, but often passing sidewise, either above the veins or covering them; tumescent at

											127
						Ca.,					128
					Mu.,				○		129
					Ma.,						130
				○							131
				R.I.,					○		132
	E,			○							133
					Ma.,						134
					Ma.,	Ca.,					135
	F,		M,		Mo., Ma.,		In.,	St.,		○	136
			M,								137
C,											138
					Ma.,	Cl.,					139
											140
					Ma.,						140
				R.I.,							141
											142
											142
											143
					Mu.,						145
—	F,				—						146
											147
											148
											149
											149
											149
											150
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											151
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											155
											156
											156
											156
								St.,			157
											158
											159
					Ma.,						160
											162
								Pi., St.,			162
			M,								163
											164
A,		Go,			Co., Mo., Ma.,	Cl.,Ca.,					164
						Ca.,					166
					Ma.,						166
									○		167
						Ca.,					168
				○							169
	F,	Go,	M,								169
											171
						Cl.,					172
					O., Ma.,						173
					Ma.,						174
											175
— C,	D, E, F,	Go,			Ma.,	Cl.,Ca.,				○	176
C,	D,				Ma., Mo.,	Cl.,				○	177
											179
											179
B,	F,		M,		Mo.,						181
		Go,			Ma.,				○	●	181
		Go,				Cl., Ca.,	St.	Pi.,	○		182
								B.,	○		183
											185
				○	Ma.,						186
			M,	○						○	186
											187
											188
											188

oblong, lanceolate, obtuse at the apex ; borders contiguous; base nearly equal, the lower obtuse. comparatively large. Venation neuropteroidal : veins forking twice, the divisions the forks, *Habitat*—Cannelton.

189	PSEUDO-PECOPTERIDS,					
190	*Pseudo-pecopteris*,					
190	P. Mazoniana,					
193	P. subcrenulata,					
194	P. Sheaferi,					
195	P. spinulosa,					
196	P. hymenophylloides,					
197	P. nervosa,			Ala., Ar.,		
198	P. subnervosa,					
199	P. Pluckneti,					
201	P. dimorpha.					
202	P. Newberryi,					
203	P. abbreviata,					
203	P. muricata,			Ala., Ar..		
205	P. cordato-ovata,			Ar.,		
206	P. Sillimanni,					Ca.,
207	P. anceps,					
209	P. decurrens,					
209	P. callosa,					
210	P. glandulosa,					Ca.,
211	P. irregularis,					
212	P. denudata,					
214	P. decipiens,			Wa., Ar., Ala., S.,		
215	P. latifolia,			Ala.. Ar.,		
215	P. acuta,			W. Va., Ala., In.,		
216	P. speciosa,			Ala.,		
217	P. Virginiana,		L.,			
217	P. trifoliata,			Ala.,		
218	P. polyphylla,			Ala.,		
219	P. macilenta,		N. R.,	Ala., W. Va.,		
220	P. pusilla,					
221	PECOPTERIDS,					
223	*Pecopteris* (*Goniopteris*),					
223	P. unita,					
225	P. emarginata,					
226	P. longifolia,					Ca.,
227	P. lanceolata,					
227	P. arguta,					
228	P. elegans,					
229	P. robusta,					
230	P. venulosa,					
	(*Cyatheites*),					
230	P. arborescens,					
232	P. platyrachis,					
233	P. nodosa,					
234	P. quadratifolia,					
235	P. squamosa,					
236	P. Strongii,					
237	P. serpillifolia,					
238	P. oreopteridis,					
239	P. pennæformis,					
240	P. dentata,					
241	P. acuta,					
242	P. aspera,					
243	P. Candolliana,					
243	P. Cistii,					
244	P. Bucklandi,					
245	P. elliptica,					
246	P. distans,					
247	P. Miltoni,					
248	P. abbreviata,					
249	P. pteroides,					
	(*Villous*),					
250	P. velutina,					
251	P. Clintoni,					
252	P. vestita,					
253	P. villosa,					
	(*Crestate*).					
255	P. erosa,					
256	P. cristata,					
256	P. serrula,					
257	P, angustissima,			Ala.,		
258	P. Hallii,					
259	P. lyratifolia,					
260	P. stellata,					
261	P. solida,					
261	P. Clarkii,					
262	P. notata,					
263	P. microphylla,					

											189
											190
					Ma.,						190
					Ma.,					?	193
			M,	○							194
				R.I.,			Dq.,				195
					Ma.,						196
—	D, E,	Go,		R.I.,	—	Ca., Cl.				○	197
						Ca.,				○	198
	E,	Go,		R.I.,	Mo.,	Ca.,	In.,			○	199
				R.I.,							201
	E,	Go,		○	Ma.,	Ca.,					202
			M,		Ma.,						203
				R I. ○	Ma.,					○	203
	E,									○	205
					Ma.,					○	206
	E,			○	Ma., Mo.,	Ca.,					207
			M,								209
					Mu.,						209
											210
					Co.,	Cl.,				○	211
						Ca.,					212
											214
				○	Ma.,					○	215
										○	215
											216
											217
					Co.,					○	217
										○	218
						Ca.,				○	219
			M,								220
											221
											223
—	E,	Go,	M,	R I. ○	Ma.,	Cl.,				○	223
					Ma.,					○	225
					Ma.,					○	226
					Ma.,						227
		Go,	M,	R.I.,	Mo., Ma., ?					○	227
	E,	Go,	M,		Ma.,			St.,		○	228
	F,	G,									229
					○						230
	E,	Go,	M,	R.I.,				Po., Pi.,		○	230
						Ca.,				○	232
			M,					Ma.,		○	233
				○	Mo.,	Ca.,	In.,				234
	E,				Ma., Mo.,	Ca.,		St.,			235
					Ma., Mo.,						236
					Ma.,						237
—	F,	Go,	M,	R.I.,	Ma., Mo.,			Po.,		○	238
	E,					Cl.,				○	239
	F,			R.I.,	Ma., Mo.,	Cl., Ca.				○	240
						Ca.,				○	241
					Mo.,					○	242
				R.I.,	Ma.,					○	243
	E, F,				Ma.,	Ca.,				○	243
	E,				Ma.,					○	244
		Go,		○							245
				○							246
	E,		M,	○				Pi., Gr., St.		○	247
	E,				Ma.,					○	248
					Ma., ?			Po.,		○	249
					○	Ca.,					250
						Cl., Ca.					251
	F,	Go,			Mo.,	Ca.,					252
	E,				Co., Ma., Mu., Mo.					○	253
	E,				Mo.,	Cl.,				○	255
					Mo.,	Ca.,				○	256
				○							256
										○	257
					Ma.,						258
					Ma., Mo.,					○	259
					Ma.,						260
					Ma.,						261
	E,			R.I.,	Ma., ?			St.,			261
C, ?			M,								262
					○					○	263

	Pecopteris.					
264	P. incompleta,					
264	P. concinna,					
265	*Oligocarpia,*					
266	O. Alabamensis,			Ala.,		
266	O. Gutbieri,					
267	O. flagellaris,					
268	SPHENOPTERIDÆ,					
269	*Sphenopteris (Pecopterid),*					
269	S. gonioptcroides,					
270	S. chærophylloides,					
271	S. mediana,					
271	S. pseudo-Murrayana,			Ar.,		
272	S. subalata,					
273	S. cristata,			Ill.,		
274	S. (*proper*),					
274	S. Gravenhorstii,					
275	S. Dubuissonis,					
276	S. mixta,					
276	S. gracilis,					
277	S. Brittsii,					
278	S. paupercula,					
279	S. scaberrima,					
280	S. microcarpa,			Ala.,		
281	S. (*Hymenophillites*),					
281	S. spinosa,*					
282	S. splendens,					
283	S. furcata,			MC., T.,		
283	S. Hildreti,					
284	S. flexicaulis,			Ar.,		
284	S. tridactylites,			In., Ill.,		
286	S. trichomanoides,			Ala.,		
286	S. quercifolia,			Ala.,		
287	S. elegans,			Ala.,		
288	S. Larischii,			Ala.,		
288	S. Hoeninghausii,			Ar., Ala., W. Va., T.		
290	S. Ballantini,			M.,		
290	S. linearis,			T.,		
291	S. flaccida,		S.,			
292	S. plicata,					
292	*Eremopteris,*					
292	E. crenulata,			Ala.,		
293	E. flexuosa,			Ala.,		
293	E. dissecta,			Ala.,		
293	E. artemisiæfolia,			Ala.,		
294	E. elegans,			M.,		
295	E. Missouriensis,					
296	E. (Triphyllopteris) microphylla,			Ala., Ky.,		
296	E. (Sphenopteris) marginata,			M.,		
297	ADIANTITES,					
297	*Triphyllopteris,*					
297	T. Lescurlana,		L.,			
299	*Archæopteris,*					
300	A. obliqua,		Po.,			
301	A. obtusa,	Ca.,	M., N. R			
302	A. minor,†	Ca.,	M., Pi.,			
304	A. Halliana,	Dev.,	N. R.,	W. Va., M.,		
305	A. Hybernica,		Pi.,			
306	A. Bockschiana,			Ma., Po.,		
307	A. Rogersi,		L., M.,			
307	Crematopteris Pennsylvanica,					
308	Pachypteris gracillima,					
309	*Rhacophyllum,*					
310	R. (*Neuropterid*),					
311	R. flabellatum,			Ill.,		
311	R. truncatum,		Pi.,			
312	R. membranaceum,					
813	R. scolopendrites,					
314	R. (*Hymenophyllites*),					
314	R. arborescens,				T.,	
315	R. lactuca,					
316	R. filiciforme,			Ar.,		
317	R. corallinum,					

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* Lately found in fine specimens in the fossil plants of the National Museum, communicated by Mr. F. W. Spencer, of Paxton, Sullivan county, Illinois; Coal L.

† Abundantly collected by Mr. A. Sherwood in the Catskill ? Red Shale of Tioga county, Pa.

			M,								264
			M,								264
											265
											266
					Ma., Mo., Va.,					○	266
				○							267
											268
											269
						Ca.,					269
	E,				Ma.,					○	270
				○	Mo.,						271
	E,			R. I.	Ma.,						271
					Mo., Ma.,	Ca.,				○	272
				R. I.	Ma.,					○	273
											274
	E,			R. I.		Cl.,				○	274
						Cl.,				○	275
		G,			Mo.,	Cl.,					276
					Mo.,					○	276
						Cl.,					277
			○				Dq.,				278
					Mo.,						279
											280
											281
					Co.,		In.,			○	281
					Co., Mo.,	Cl.,					282
	E,				Mo.,					○	283
					Ka.,						283
											284
	E,				Mo., Ma.,	Cl.,				○	284
					Mo.,	Cl.,				○	286
										○	286
					Ma.,					○	287
										○	288
										○	288
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										○	290
										○	291
				○							292
											292
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											293
					Ky., Mo.,	Ca.,				○	293
						Ca.,					294
						Cl.,					295
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											300
											301
											302
											304
										○	305
										○	306
											307
								○			307
					Mo.,	Ca.,					308
											309
											310
					Ma.,					○	311
											311
						Cl.,					312
			M,								313
											314
					Mo.,						314
		Go,	M,		Ma.,	Ca., Cl.,				○	315
C,	E,	Go,			Ma.,	Cl.,				○	316
					Ma.,						317

	Rhacophyllum.					
317	R. cornutum,					
318	R. hirsutum,					
318	R. fimbriatum,					
319	R. Clarkii,					
320	R. spinosum,					
321	R. hamulosum,					
321	R. adnascens,					
322	R. trichoideum,					
323	R. inflatum,					
323	R. expansum,					
324	R. thalliforme,					
324	R. (*Fucoid*),					
325	R. fucoideum,					
325	R. Strongii,					
326	R. molle,					
326	R. irregulare,					
327	*Sorocladus*,					
328	S. stellatus,			Ar.,		
328	S. asteroides,					
329	S. sagittatus,					
329	S. ophioglossoides,					
330	S. Worthenii,					
331	*Rachiopteris*,					
331	R. affinis,					
332	R. selago,					
332	R. pinnata,	Dev.,				
332	R. cyclopteroides,	Dev.,				
332	R. punctata,	Dev.,				
333	R. striata,	Dev.,				
333	R. tenuistriata,	Dev.,				
333	*Stigmarioides*,					
333	S. Evenii,					
334	S. truncatus,					
334	S. villosus,					
335	S. tuberosus,					
335	S. linearis,					
337	*Stemmatopteris*,					
337	S. hirsuta,					
337	S. emarginata,					
338	S. Schimperi,					
339	S. squamosa,					
339	S. angustata,					
339	S. punctata,					
340	S. insignis,					
340	S. gigantea,					
341	S. cyclostigma,					
341	S. mimica,					
342	S. polita,					
342	S. Worthenii,					
343	*Caulopteris*,					
343	C. Giffordi,					
344	C. Lacoei,					
344	C. obtecta,					
345	C. Cistii,					
346	C. Mansfieldi,					
347	C. Lockwoodi,	Dev.,				
347	C. antiqua,	Dev.,				
348	C. peregrina,	Dev.,				
348	*Megaphytum*,					
349	M. McLayi,					
349	M. Goldenbergii,					
350	M. Grand 'Euryi,					
352	M. protuberans,					
353	Psaronius.					
355	LYCOPODIACEÆ.					
357	*Lycopodites et Selaginites*,					
357	L. pendulus,					
357	L. Meekii,					
358	L. cavifolius,					
359	L. uncinnatus,					
359	L. Ortoni,					
360	L. strictus,					
361	L. annulariæfolius,					
362	L. Richardsoni,	Dev.,				
362	L. comosus,	Dev.,				
362	L. Vanuxemi,	Dev.,				
363	*Lepidodendron*,					
366	L. Sternbergii,			Ala., W. Va.,		

					Ma.,	Cl.,					317
			M,		Ma.,	Cl.,					318
			M,			Cl.,					318
	E,	Go,		R.I.,	Ma.,	Ca.,					319
						Cl.,					320
						Cl.,					321
—					—					○	321
	E,										322
							D,				323
		Go,									323
					Co., Ma.,						324
											324
					Ma.,						325
					Ma.,						325
					Ma.,						326
									○		326
											327
											328
					Mo.,						328
					Ma.,						329
						Cl.,					329
					Ma.,						330
											331
					Ma.,						331
					Ma.,						332
											332
											332
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											333
					Ma.,						333
					Ma.,						334
					Ma.,						334
					Ma.,						335
					Ma.,						335
											337
		Go,			Ma.,	Ca.,					337
						Ca.,					337
						Ca.,					338
		Go,				Ca.,					339
						Ca.,					339
		Go,	M,			Ca.,					339
							D,				340
C,									○		340
		Go,				Ca.,					341
						Ca.,					341
						Ca.,					342
								C,			342
											343
									○		343
	E,	Go,									344
	E, D,				Mo.,	Ca.,					344
	E,	Go,			Mo.,	Ca.,	○			○	345
						Ca.,					346
											347
											347
											348
											348
					Mo.,	Ca.,	S.				349
						Cl.,				○	349
		Go,									350
								C,			352
								P,			353
											355
											357
					Mo.,						357
					Mo.,						357
					Ma., Ky.,						358
					Co.,						359
							N.,				359
								In.,			360
					Ma.,						361
											362
											362
											362
											363
—	E,	Go,			Ma., Mo.,	Ca., Cl.,				○	366

	Lepidodendron.					
368	L. Brittsii,					
369	L. lanceolatum,					
369	L. scutatum,					
370	L. latifolium,					
370	L. Morrisianum,					
371	L. aculeatum,					
372	L. rigens,					
373	L. longifolium,					
374	L. Veltheimianum,			Ill., Ala., Ar.,	J.,	Co ,
376	L. squamiferum,*			Ala.,		
377	L. primæve,	Dev.,				
377	L. corrugatum,	Ch.,	Po.,S.,	Ar.,		
379	L. vestitum,			Ar.,		
379	L. Rushvillense,†			M.,		
380	L. clypeatum,			Ala.,		
381	L. costatum,			Ill.,		
382	L. turbinatum,			Ill.,		
382	L. rhombicum,					
383	L. quadrangulatum,					
384	L. dichotomum,					
385	L. modulatum,			Ar.,		
386	L. carinatum,					
387	L. distans,					
388	L. cuspidatum,					
388	L. Worthenii,					
389	L. Andrewsii,					
389	L. quadrilaterale,			M.,		
390	L. forulatum,					
390	L. diplotegioides,			Ar.,		
391	L. Tijoui,					
392	L. obtusum,					
392	L. rimosum,					
394	L. crenatum,				Ill.,	
394	L. cyclostigma,					
394	L. Mielickii,					
395	L. Gaspianum,	Cat.,	N. R.,			
396	L. Chemungense,	Ch.,				
396	L. icthyolepis,					
397	L. obscurum,			Ill.,		
397	L. radicans,					
397	*Ulodendron*,					
401	U. commutatum,			Ala.,		
401	U. majus,			Ala.,		
403	U. minus,			Ala., T.,		
404	U. ellipticum,					
405	U. elongatum,					
405	U. punctatum,					
407	*Knorria*,					
407	K. imbricata,			Ill., Ar.,		
409	*Halonia*,					
411	H. tuberculata,			Ill.,		
413	H. tortuosa,					
414	H. (Ulodendron) Mansfieldi,					
416	H. (U.) flexuosa,					
417	H. pulchella,			Ar.,		
417	H. secreta,					
418	*Lepidophloios*,					
420	L. crassicaulis,			Ala.,		
421	L. auriculatus,					
422	L. laricinus,			T., Ala.,?		
423	L. obcordatus,					
424	L. macrolepidotus,					
425	L. sigillarioides,					
425	L. protuberans,					
426	L. ichthyoderma,					
427	Fructifications of Lepidophloios,					
429	*Cyclostigma*,					
429	C. Kiltorkense,					
430	*Dechenia*,					
431	D. striata,					

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* *Lepidodendron Volkmannianum*, a subcarboniferous species in Europe, has been sent by M. Harvey, from Arkansas.

† *L. Rushvillense* is apparently identical to *L.* (*Sagenaria*) *depressum*, Goepp., Uebegsg., p. 179, Pl. XLIII, which Schimper records from Mauch Chunk, Penna., from specimens in the Museum of Strasbourg.

						Cl.,					368
						Cl.,					369
						Cl.,					369
C,											370
					Mo.,						370
C,	E,	Go,		R.I.,	Ma.,	Ca.,				○	371
					Ma.,	Ca.,				○	372
	E,									○	373
—B, C	E, F,	Go,								○	374
											376
											377
											377
B, C,		Go,			Ma.,						379
										○ ?	379
—C,	E,	Go,			○	Ca.,					380
											381
											382
	E,				Ky.,					○	382
									○	○	383
—				R.I.,	—					○	384
—B, C	E,	Go,			Mo., Ma.,	Ca.,					385
B, C,											386
B, C,											387
	E, F,										388
					Mu.,						388
					Ma.,						389
											389
							Dq.,				390
					Co.,						390
	E,			○				St.,			391
B, C,	E,			○							392
B,	E,				Co., Mo.,					○	392
	E,									○	394
						Cl.,					394
○										○	394
											395
											396
				○							396
											397
							D,				397
											397
	F,									○	401
—	E,				Co., Mo., Ma.,					○	401
	D, E,									○	403
	D, E,				Mo., Ma.,					○	404
	E,				Mo.,						405
C,					○ Co.,	Ca.,				○	405
											407
B,	E,									○	407
											409
										○	411
					○					○	413
						Ca.,					414
○ ?										○	416
											417
							○				417
											418
○ ?					Mo.,					○	420
							St.,				421
○ ?					Mo.,						422
					Co.,		D,				423
									○	○	424
						Cl.,					425
	E,				Mo.,						425
					Mo.,						426
						Ca.,					427
											429
									○	○	429
									○		430
											431

431	*Lepidostrobus*,					
432	L. Goldenbergii,					
433	L. prælongus,					
434	L. princeps,					
434	L. variabilis,					
435	L. spectabilis,					
436	L. lancifolius,					
436	L. lanceolatus					
437	L. oblongifolius,					
438	L. ovatifolius,					
438	L. hastatus,					Ca.,
439	L. Lacoei,					
440	L. ornatus,					
441	L. Aldrichi,			Al.,		
411	L. connivens,					
442	L. species,					
442	L. incertus,					
443	L. *Macrocystis*,					
443	L. (M.) Salisburyi,					
444	L. (M.) quadratus,					
444	L. (M.) Mansfieldi,					
415	L. (M.) foliaceus,					
446	L. (M.) mirabilis,				Y.,	
447	*Lepidophyllum*,					
447	L. affine,					
447	L. brevifolium,					
448	L. tumidum,					
448	L. Morrisianum,					
449	L. majus,			Ar.,		
449	L. Mansfieldi,					
450	L. auriculatum,					
450	L. acuminatum,					
451	L. obtusum,					
451	L. rostellatum,					
452	L. striatum,					
452	L. linearifolium,					
454	*Lepidocystis*,					
454	L. pectinatus,					Ca.,
454	L. lineatus,					
455	L. quadrangularis,					
455	L. obtusus,					
456	L. angularis,					Ca.,
457	L. vesicularis.					Ca.,
457	L. fraxiniformis,			Po.,		Ca.,
458	L. bullatus,					Ca.,
458	*Sporocystis*,					
458	S. planus,					Ca.,
459	*Psilophyton*,					
459	P. princeps,	Dev.,				
460	Leptophlæum rhombicum,	Dev.,				
461	*Tæniophyllum*,					
464	T. decurrens,					
465	T. contextum,					
465	T. deflexum,					
466	SIGILLARIÆ,					
	Sigillaria—1. Leiodermariæ.					
468	S. monostigma,					
470	S. fissa,					
470	S. obliqua,					
471	S. spinulosa,					
472	S. dilatata,					
473	S. reticulata,			Ar., Ala.,		
473	S. Lorenzii,					
474	S. stellata,					
474	S. Schimperi,					
475	S. corrugata,					
476	S. leioderma,					
477	S. lepidodendrifolia,					
	2. Clathrariæ.					
477	S. Brardii,					
479	S. Menardi,					
480	S. Serlii,					
	3. Rhytidolepis.					
480	S. Dournaisii,			Ala.,		
481	S. tessellata,					
182	S. ichthyolepis,					
483	S. hexagona,					
483	S. mamillaris,			P., W. Va.,		
485	S. Lescurii,					

											431
		Go,			Ma.,	Ca.,				○	432
C.,	E,										433
					Mo., Co.,		D,				434
	F,	Go,					Ca.,			○	434
						Ca.,					435
	E,				Ma.,						436
C,	E, F,									○	436
	E,				Ma.,						437
	E,				Ma.,						438
○					Ma.,						438
		Go,									439
	E, F,				Ma.,	Ca.,				○	440
	E,				Ma.,						441
					Ma.,						441
					Ma.,						442
					Mo.,						442
											443
					○						443
						Ca.,					444
						Ca.,					444
					Mu., Mo., Ma.,	Ca.,					445
											446
											447
	E,										447
○	E,				○						447
		G,		R.I.,							448
					Mo.,						448
—	E,	Go,			Mo.,	Cl.,				○	449
						Ca.,					449
					Mo.,		St.,				450
	E,				○						450
	E,				○						451
	E,	Go,			Ma.,						451
	E,				Ma.,						452
C,											452
											454
											454
			M,								454
	E,										455
C,	E,										455
	E, F,					Ca.,					456
					Mo., Mu.,	Ca.,					457
	E,									○	457
					Mo., Ma.,						458
											458
											458
											459
											459
											460
											461
						Ca.,					464
						Ca.,					465
						Ca.,					465
											466
B,					Co., Mo.,	Ca.,					468
				○							470
	E,	Go,	M,				D,			○	470
					Ma.,				○	○	471
B,				○							472
											473
	E,										473
B,											474
				○							474
					○						475
				○					○	○	476
				○	Mo.,					○	477
C,	E,	Go,			Co.,	Ca.,	D,	W. Po.,		○	477
C,	E,			○				Po.,		○	479
	E,									○	480
										○	480
C,	E, F,				Mu.,	Ca.,				○	481
									○	○	482
									○	○	483
—	F,	Go,								○	483
○											485

	Sigillaria—3. Rhytidolepis.					
486	S. notata,					
486	S. cuspidata,					
487	S. Massilliensis,					
488	S. attenuata,					
488	S. Williamsii,					
489	S. leptoderma,					
490	S. pulchra,				Y.,	
490	S. polita,					
491	S. Yardlei,					
491	S. orbicularis,					
492	S. Volzii,					
493	S. Pittstoniana,					
493	S. Sillimanni,					
494	S. elliptica,				Cu.,	
495	S. ovalis,					
495	S. Cortei,					
496	S. obovata,					
496	S. acuminata,				Cu.,	
497	S. rugosa,					
498	S. marginata,					
499	S. Lacoei,					
500	S. lævigata,					
501	S. reniformis,					
502	*Syringodendron*,					
502	S. Porteri,					
503	S. pachyderma,					
504	S. Brongniarti,					
505	S. cyclostigma,					
505	S. Vanuxemi,	Ch.,				
506	S. gracile,	Dev.,				
506	*Didymophyllum*,					
506	D. reniforme,	Dev.,				
507	D. (Sigillaria) Owenii,					
509	*Stigmaria*,					
514	S. ficoides et var.,	—				
516	S. umbonata,					
516	S. amoena.					
516	S. stellaris,					
517	*Sigillarioides*,					
517	S. radicans,					
518	*Pinnularia*,					
518	*Spirangium*,					
519	S. Prendelii,					
520	S. appendiculatum,					Ca.,
520	S. multiplicatum,					
521	S. intermedium,					Ca.,
521	NOEGERATHIÆ,					
523	*Whitteleseya*,					
523	W. elegans,				Cu.,	
524	W. integrifolia,			Ala.,		
525	W. undulata,			Ala.,		
525	CORDAITEÆ,					
527	*Cordaites*,					
529	C. validus,					
530	C. crassus,					
530	C. grandifolius,					Ca.,
532	C. borassifolius,					Ca.,
533	C. lingulatus,					
534	C. communis,					
535	C. Lacoei,					
535	C. diversifolius,					
537	C. Mansfieldi,					
539	C. gracilis,					
540	C. radiatus,					
540	C. costatus,					
542	C. serpens,					
543	C. Robbii,	Dev.?		W. Va.,		
544	C. angustifolius,	Dev.,				
544	C. flexuosus,	Dev.,				
545	*Cordaianthus*,					
545	C. ovatus,					
546	C. dichotomus,					
547	C. (baccifer),				Y.,	
549	*Cordaicarpus*,					
549	C. Gutbieri,					
550	C. ovatus,					
551	C. apiculatus,					
551	*Cordaistrobus*,					
552	C. Grand 'Euryi,					

			M,							○	486
	F,									○	486
					Mu.,						487
○	F,										488
		Go,									488
	F,										489
											490
C,											490
	F, E,	Go,									491
	F,									○	491
	F,									○	492
	F,	Go,									493
	F,			○						○	493
	F,	Go,				Ca.,				○	494
	F,										495
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	F,										496
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	○									○	497
	F,										498
	F,										499
C,	F,									○	500
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—	F,				○?					○	503
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	E,										516
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	E,					Ca.,					529
	E,									○	530
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C,	E,				—					○	532
B, C,	E,									○	533
	E,					Cl.,					534
	E,										535
	E,		M,		Co., Mo.,	Cl.,	St., D.,	S.,			535
						Ca.,					537
					Mo.,						539
						Ca.,					540
						Ca.,					540
						Ca.,					542
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											544
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						Ca.,				○	545
						Cl.,					546
						Ca.,		Po.,		○	547
											549
C,	E,					Ca.,				○	549
						Ca.,				○	550
						Ca.,					551
											551
						Ca.,					552

553	*Dicranophyllum*,					
553	D. dichotomum,					
554	D. dimorphum,					
556	*Desmiophyllum*,					
557	D. gracile,					
557	*Lepidoxylon*,					
557	L. anomalum,					
561	*Cardiocarpus*,					
562	C. samaræformis,				Cu.,	
563	C. Newberryi,			M.,		
563	C. ingens,			Ala.,		
564	C. affinis,			Ala.,		
564	C. annulatus,				Y.,	Ca.,
565	C. pachytesta,					Ca.,
565	C. (Ptilocarpus) bicornutus,					
567	C. latus,				Cu.,	Ca.,
567	C. minus,				Cu.,	Ca.,
567	C. elongatus,				Y.,	Ca.,
568	C. (*Samaropsis*) zonulatus,					Ca.,
568	C. (S.) late-alatus,					Ca.,
569	C. (S.) simplex,					Ca.,
569	C. orbicularis,			Ar.,	Cu.,	
570	C. diminutivus,					Ca.,
570	C. fasciculatus,					Ca.,
571	C. apiculatus,					Ca.,
571	C. mamillatus,					
572	C. regularis,					Ca.,
573	C. congruens,					Ca.,
573	C. marginatus,					
573	C. bicuspidatus,				Cu.,	
574	*Rhabdocarpus*,					
575	R. insignis,					
575	R. Howardi,					
576	R. Jacksonianus,				Cu.,	Ca.,
578	R. multistriatus,					Ca.,
579	R. carinatus,				Cu.,	
579	R. acuminatus,				Y.,	
579	R. lævis,				Cu.,	
580	R. Danai,					Ca.,
581	R. clavatus,			Ala.,		
581	R. amygdalæformis,					Ca.,
582	R. latemarginatus,			Ar.,		Ca.,
583	R. minutus,			Ar.,		Ca.,
583	R. cornutus,					
583	R. arcuatus,					
584	*Trigonocarpus*,					
584	T. Noeggerathi,					
586	T. Dawesii,					
586	T. Bertholetiformis,					
587	T. Saffordi,			T.,		
587	T. magnus,					
588	T. juglans,				Cu.,	Ca.,
588	T. Hildreti,					
589	T. trilocularis,			W. Va.,	Cu.,	
589	T. Parkinsoni,			Ar., T.,		
590	T. olivæformis,					
590	T. Menzelianus,					
591	T. tricuspidatus,					
591	T. ornatus,				Cu.,	
592	T. multicarinatus,				Cu.,	
592	T. Giffordi,					
593	*Carpolithes*,					
593	C. bifidus,					
594	C. fasciculatus,					
595	C. cistula,					
595	C. corticosus,					
595	C. persicaria,					
596	C. acuminatus,					Ca.,
596	C. retusus,				Cu.,	Ca.,
596	C. fragarioides,				Y.,	
597	C. Trevortoni,					
597	Cardiocarpus plicatus,					
597	C. punctatus,					
598	Carpolithes spicatus,	Dev.,				
598	C. lunatus,	Dev.,				
598	C. siliqua,	Dev.,				
599	*Codonospermum*,					

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							Ca.,					553
							Ca.,					554
												556
							Ca.,					557
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							Cl.,					557
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B,	E,				Ma.,							571
							Ca.,				○	572
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B,											○	573
			M,								○	573
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	F,											575
										○		575
	E,	Go,			Mu.,							576
B, C,	E,	Go,			Co.,		Ca.,		St.,		○	578
												579
	F,											579
									In.,			579
	F,				Z.,	○						580
					Ma.,		Ca.,				○	581
B,	E,						Ill.,				○	581
												582
												583
					Ma.,							583
					Ky,							583
												584
					Ma.,	○					○	584
B, C,					In.,		Ca.,				○	586
										○		586
												587
								Co.,				587
	E,				Mu.,							588
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												589
							Ca.,				○	589
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						○					○	590
	E,?											591
												591
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						○						592
												593
			M,	○							○	593
	F,?								Gr.,			594
C,	E,				Mu.,		Ca ,					595
					Ma.,							595
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CHAPTER III.

Amount of Materials composing the Coal Flora.

§ 39. Of the species of the Coal flora, named in the Table of Distribution, a few have been found and determined after the printing of the descriptive part. It is proper to mention them here in order to indicate the localities wherefrom they are derived and the names of the discoverers.

From Cannelton, Mr. I. F. Mansfield has sent: *Asterophyllites grandis*, *Neuropteris Grangeri*, one leaflet which seems referable to *N. Agassizi* (or perhaps represents a form of *Odontoperis Alpina*), *Pecopteris Cistii*, *P. Clintoni*, *P. vestita*, *P. dentata*, *Lepidodendron aculeatum*, *Rhabdocarpus clavatus*, and especially a beautiful specimen, the top of a pinna of *Dictyopteris neuropteroides*, Gutb.

From Arkansas we have from Mr. F. L. Harvey: *Conostycus Broadheadi*, *Asterophyllites gracilis* (in numerous fragments, some of them fructified), *Calamostachys typica*, Schp. (a splendid specimen, with fructifications distinct), *Alethopteris Helenæ*, *Pseudopecopteris muricata* (abundant), *P. latifolia*, *P. cordato-ovata*, *Sphenopteris crenata*, *S. pseudo-Murrayana*, *S. Hoeninghausii*, *Rhacophyllum filiciforme*, *Lepidodendron Veltheimianum*, *L. modulatum*, *Sigillaria reticulata*, *Cardiocarpus orbicularis* (in numerous specimens), *Trigonocarpus Parkinsoni*, and two new species of *Sphenopteris* of the type of *S. Hoeninghausii*.

From Mr. P. W. Emerson, St. Clairsville, we have still: *Neuropteris anomala*, *Pecopteris elegans*, *P. squamosa* (? a specimen too small for positive identification), *P. Clarkii*, *P. Miltoni* and *Rhabdocarpus multistratus*.*

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* Some species described by Prof. Fontaine in his memoirs on the New river and on the Conglomerate measures of W. Virginia are named here below, for a separate comparison of the plants of these groups.

A recent revision made in the cabinet and with the assistance of Mr. R. D. Lacoe, of the fossil plants found around Pittston, has enabled me to fix with more precision the reference of the species to their horizon.

§ 40. Prof. Schimper, in his Vegetable Paleontology, describes, deducting the synonymy, eight hundred and thirty species from the coal measures of Europe. About one hundred have been discovered there since the publication of that work.

Of the whole number (say 930) nearly two hundred are recognized in the coal measures of North America.

These European species, referable to all the sub-divisions of the carboniferous, have been described by more than fifty different authors, from Schlotheim, 1804, to the present time.

As seen from the table we know as yet from the U. S. coal measures six hundred and thirty-five species, most of them described since 1850; for before that time a few coal plants only were published or figured by Steinhauer, 1818, and a few others (seventeen) by Brongniart (1828–1844) from American specimens.

These materials we have to use:

For a comparison of the U. S. Coal Flora with that of Europe.

For a few remarks on the geographical distribution of the plants.

For an exposition of their stratigraphical distribution.

For a review of the origin, succession and modifications of some of the more important vegetable types, from the base of the coal measures upwards.

CHAPTER IV.

The U. S. Coal Flora compared to that of Europe.

§ 41. For the Thalamophytes or marine plants, no point of comparison is found in the European coal flora. The species described in this volume are as yet the only representatives of marine plants found in the coal measures of any country.

§ 42. With few exceptions, the *Calamariæ* are the same on both continents. All our *Calamites* except two, insufficiently defined from poor specimens, are European. The number of species of *Calamites* is, however, uncertain, as the authors generally differ on the value of the specific characters of these plants. *Calamodendron* which I have placed in this order belongs to the upper coal measures of Europe, the Permo-Carboniferous and Permian; the characters of the plants are recognized mostly from anatomical analysis which we are unable to do here. Of *Asterophyllites*, three species pertain as yet exclusively to the American flora, and three species also of *Sphenophyllum*. *Annularia* species are identical, excepting *A. inflata*, which may be a mere form of *A. longifolia*. I believe, therefore, that when the species of the *Calamariæ* are defined by more complete specimens, scarcely any difference will be remarked between the European and the American representatives of this order.

The genus *Trochophyllum*, hypothetically added to this division is formed of two exclusively American plants.

§ 43. In the Ferns, the differences are very great, one third only of the two hundred ninety-four species described from the U. S. Coal Measures being considered identical with those of Europe. This difference seems at first peculiar and might be supposed to result essentially from uncertain determinations, if it were not rendered evident by a number of peculiar distinct types. Merely quoting the more remarkable ones, we have: *Neuropteris laciniata*, *Rogersi*, *Clarksoni*, *Desorii*, *rarinervis*, *Agassizi*, *anomala*, *verbenæfolia*. *N. fimbriata* was considered for years a type peculiar to America, but a relative species has been found more recently in the anthracite of the Alpine mountains of Savoy. In *Odontopteris*, we have: *O Newberrii*, *cornuta*, *heterophylla*, *Worthenii*, *subcuneata*, *gracillima;* and then *Lesleya grandis*, *Dictyopteris rubella*, all the *Megalopteris*,* *Tæniopteris Smithsii*, *Neriopteris*, *Orthogoniopteris*, *Danæites*, *Idiophyllum* especially, whose characters are without analogy to any coal plant of Europe. In the genera *Alethopteris*, *Pseudopecopteris*, *Pecopteris*, *Sphenopteris* and *Archæopteris*, one half of the species are identical, and most of those considered as distinct have characters striking enough to have been recognized as specific by Schimper, Grand'-Eury and other European authors.

The more marked difference is in the species of the genus *Rhacophyllum*, of which nineteen are described from American specimens, four of which only are European. These plants appear to have been either parasitic upon other Ferns or sometimes merely protophylles, like the foliaceous patches preceeding the unfolding of stems and fronds of some Ferns. A number of these vegetable organisms are found exclusively in nodules or iron concretions wherein the more delicate parts of plants have been preserved. This may account for the great number of species we have of this genus, and also for the separate fruiting fragments of Ferns described under the name of *Sorocladus* and of rhizomas, none of which have been discovered in Europe.

The preponderance of Fern-trees in the U. S. coal flora, seen by remains of *Stemmatopteris*, *Caulopteris*, and *Megaphytum*, was probably caused by peculiar differences in the atmospheric circumstances. Of these genera we have twenty-four species, two of which only, *Caulopteris Cistii* and *Megaphytum McLayi*, are identified from Europe.

§ 44. The *Lycopodiaceæ* have, here as in Europe, entered to a great extent into the composition of the coal. The number of species of this class, recognized in the American coal measures is increased by fructifications, some of these of peculiar conformation, which for the genera *Lepidophyllum*, *Lepidocystis*, *Sporocystis*, have scarcely been described by European authors.

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*Saporta (in letter) says that fragments of large leaves probably referable to this genus have been discovered in France.

The genus *Lepidodendron* is represented in Schimper's Veget. Paleont. by fifty-nine species, deducting the synonyms, thirty to forty in number. Of the species, twelve are identified in the U. S. Coal measures, besides twenty-nine described as new.

For this genus and for *Sigillaria* also, the characters we have for determination are merely taken from the scars left on the bark, as points of attachment of the leaves. As they are variable in their characters at different ages, it has been asserted, perhaps with reason, that the number of species is by far too widely increased. I have already remarked on the subject, p. 364. I have only to add, that from the number of species published in these two genera from the European coal flora, it would be rational to come to a contrary conclusion. Schimper, after carefully reducing the number of species by elimination of those considered as synonyms, has still, for *Lepidodendron*, seven to eight per cent. of the species of the whole coal flora, and for *Sigillaria* ten per cent., while the *Lepidodendron* make only six and a half and the *Sigillaria* eight per cent. of the species described in this flora.

I believe, however, that for these two genera, still more than for the Ferns, the number of species may be reduced hereafter by comparison of American with European specimens, although we have, as for the Ferns, some peculiar types which, without analogy to any of those recognized in Europe, evince the continental character of each flora. Of this kind are *Lepidodendron Brittsii*, *latifolium*, *squamiferum*, *corrugatum*, *costatum*, *turbinatum*, *Worthenii*, *diplotegioides*, and also (though contested) the common *L. clypeatum*.

Our species of *Lycopodites* are also mostly distinct, especially *L. strictus* and *L. annulariæfolius*. One, *L. Ortoni*, belongs to the group of Lycopods with dimorphous leaves (*Selaginelta*), represented in Europe by four different species.

In *Ulodendron* the species are identical except one.

Halonia has three identical species, one related and two of peculiar types ; while of the *Lepidophloios*, only two of the eight species described here are identified in Europe.

It is especially in the fructifications of the *Lycopodiaceæ : Lepidostrobus*, *Lepidophyllum*, *Lepidocystis and Sporocystis*, that we have here a number of greatly diversified forms most of them unknown in Europe. These vegetable remains have been obtained mostly in the nodules of Mazon creek, the shale of the Morris coal, those of Cannelton, and in the intra conglomerate shale (the Campbell's ledge) of Pittston. Of eleven species of *Lepidostrobus*, and five of *Lepidophyllum*, three only are European. All the species of *Lepidostrobus* (*Macrocystis*) and all those of *Lepidocystis* and *Sporocystis* are exclusively American.

The number of fructifications of the *Lycopodiaceæ*, is comparatively far above that of the species of *Lepidodendron*. The very distinct and peculiar characters of these remains forces upon us the conclusion that the trees of this class of plants were more diversified in genera and species than is generally believed.

§ 45. What is said for the *Lycopodiaceæ* may be repeated for the *Sigiltariæ*, except for the fructifications, of which as yet scarcely anything is known. Possibly the species of *Lepidostrobus* (*Macrocystis*) may be referable to *Sigillariæ*. If this were ascertained, the group should be definitely placed with the *Lycopodiaceæ*. But as yet we have no positive proof of the relation. Remains of *Macrocystis* at Cannelton correspond in abundance to those of *Sigillaria monostygma* only ; for this locality has merely rare specimens of a few other *Sigittaria* and *Lepidodendron*.

The number and proportion of species of *Sigillaria* to the flora is remarked above. Of the fifty species described here half of them are European. As essentially distinct types besides *S. monostigma* we have : *S. reticulata*, *stellata*, *Schimperi*, *corrugata*, *Massiliensis*, *acuminata*, *Pittstoniana* and *Lacoei*.

Remains of *Stigmaria* are found everywhere in abundance, as said already, from the lowest to the upper coal strata, over the whole extent of the coal measures. The flora of the Michigan coal is as yet known to me only by the communication of a large number of specimens of *Stigmaria.* Most of the species or varieties are common to the coal flora of both continents.

The genus *Spirangium* is represented in the U. S. Carboniferous by four distinct species, two of which have been found in the sub-conglomerate ledge of Pittston. Until now it has no representatives in that of Europe where plants of this kind appear later, mostly in the Trias. *S. carbonarium*, Schp., only, is from the New Red or Lower Permian of Saxony. The author remarks on it that the existence of this vegetable type positively dates from the Permian.

The *Cordaiteæ* are particularly interesting on account of its now generally acknowledged relation to the Gymnosperms.

Until 1877, when the flora of Grand'Eury was published, the *Cordiateæ* were known merely from fragments of leaves, and their affinities were not clearly defined. From the remains described in that work and from the numerous specimens discovered in the U. S. Coal measures, the characters of these plants and their distribution have been more distinctly exposed. The species are difficult to separate. Of thirty referable to this order, and described here as stems, leaves, flowers and fruits, eight only are identified with those of Europe. The differences in typical characters between the plants of both continents are still more striking in this order than in the *Sigillariæ*. *Cordaites grandifolius*, *Lacoei*, *diversifolius*, *gracilis*, *radiatus*, *costatus*, *serpens*, are quite as distinct as species as *Cordaistrobus* and *Desmiophyllum* are as genera.

As yet ripe or full grown fruits of *Cordaites* still attached to stems, have only been found in the U. S. Coal measures.

§ 46. The seeds are described as *Cardiocarpus*, *Rhabdocarpus*, *Trigonocarpus* and *Carpolithes*. Those referable to *Cardiocarpus* are generally small, locally distributed, and of difficult determination. They represent mostly new species. Of the twenty-two described here eighteen are of the sub-conglomerate measures, and of these only five are identified with European ones. Of over fourteen species of *Rhabdocarpus* three are European, and of *Trigonocarpus*, mostly sub-conglomerate, we have fifteen species, five of which only are European. This genus, like *Cardiocarpus*, is in the U. S. Coal measures especially represented in the Sub-conglomerate.

§ 47. After marking the relation and differences in the plants of the Carboniferous of both continents, can we positively assert that the flora represents the vegetation of one and the same epoch? The climatic circumstances, temperature, atmospheric humidity, etc., being identical at that time over the whole Northern hemisphere, is it not fair to suppose that the plants should be exactly the same here as they were in Europe?

The geographical distribution of the plants does not merely depend upon the atmosphere. The nature of the land, its mineral compounds, the origin of the vegetable types, their deviations and modifications in passing to species or genera, the transfer of seeds, and a quantity of other causative agents modify the characters of the vegetation and its distribution even at short distances. For example, the bed of coal shale at Morris is the equivalent of that of Mazon creek; the formation is identifiable over the interval of ten or twelve miles which separates the localities where plants have been most searched for and collected. Now from Mazon creek we have eighty-five species not seen at Morris, while thirty-five found at Morris have not been seen at Mazon creek. Setting aside the species of general distribution, the two localities have only fifteen species in common.

The most common vegetable types of the Coal epoch are all identical on both continents. As we have seen above, very few of the American genera are not represented in Europe, and *vice versa*. Of the species described from the U. S. Carboniferous, as indicated by the table, one hundred and ninety-two, or one-third, are European.

This is sufficient to prove a most intimate correlation of the floras of both continents at the Carboniferous age.

Chapter V.

Geographical distribution of the plants of the U. S. Coal measures.

§ 48. There is no special remark to make on this subject. A comparison of the species found at different localities whose horizon is recognized, the same shows their geographical distribution. The different localities of one and the same geological age are placed in the same column of the table of distribution. On the third column (the Sub-conglomerate), for example, one hundred and five species are indicated as contemporaneous or occurring in the coal fields at the same period of time. It indicates also that about one third of these species are found at far distant localities, as in Arkansas, West Virginia, Alabama, Illinois, Kentucky, &c., some at a single locality, others at two, others at three or four. Addition of species to the column by new discoveries will by and by complete and more distinctly interpret the characters of the flora of the Sub-conglomerate.

It is the same case with the different stations indicated by the columns of the table. Long and continued researches at distant localities whose horizon is ascertained, afford points of comparison for the representation of the geographical distribution.

On this subject we have, besides those marked in the Sub-conglomerate, important points of observation for coal A. In Illinois, at Mazon creek, Morris, Murphysborough, Colchester, &c.; in Missouri, at Clinton; in Pennsylvania, at Cannelton and Pittston. Of the plants of these localities, which I consider as representing a coeval flora, about three hundred and eighty species have been already obtained up to the present time. These materials afford ample means for comparison.

The station of Mazon creek, that of Cannelton, and the Campbell's ledge of Pittston, are for the geographical distribution by far the more important ; not merely for the abundance of the specimens obtained from each locality, but because they more fully represent than any other the characters of the vegetation of the time.

In all the other localities, the plants here described have been found in the top shale of the coal strata and, therefore, merely exhibit a diminutive part of the whole flora which may have contributed to the constituent of a coal bed, or the plants living during a fraction of the whole period of time necessary for that formation. But the nodules of Mazon creek are derived from a stratum of soft clayey shale three to eight feet thick. The bed has been washed through centuries by the water of a creek. The heavy iron-stones in which the remains of plants are imbedded have been spread and heaped, mixed together upon a wide bottom ; therefore, these nodules represent the vegetation of a whole or at least of a prolonged period. For this reason, as also for the more perfect preservation of soft fragments of plants, which are generally destroyed in the top shale of the coal beds, the flora of that locality is remarkably rich and important.

The plants at Cannelton are found in a lower bed of shale or shaley cannel coal, four feet thick, which is entirely taken out of the mines and carefully examined, in its whole thickness for the vegetable remains which it abundantly contains, and which, as at Mazon creek, represent plants composing the flora of the coal during a prolonged period.

It is the same with those found in the shale of the Campbell's ledge near Pittston. This bed, four feet thick, is also entirely quarried out and searched in its whole thickness for the collection and examination of its vegetable remains.

CHAPTER VI.

Stratigraphical distribution of the coal plants.

§ 49. The marine plants cannot be taken here into consideration, as they cannot offer any positive indication in regard to the horizon of the strata where they are found, and, indeed, are not likely to afford in future time documents of importance on the subject. This, not merely on account of the vagueness of their characters or the difficulty of their determination, but because their types are preserved for a vast period of time. Species of marine Algæ apparently identical are observed from the Devonian to the Cretaceous.

I do not take any account of the species mentioned from the Devonian and the Catskill group. They are considered in the remarks on the succession and development of vegetable types.

§ 50. To the column of the Pocono are referred the plants partly described by Prof. Fontaine from the New River group, with those obtained by Prof. Meek from the Lewis tunnel, of Allegheny county, Virginia; a few from Pottsville, Mauch Chunk, Pittston, and those from the Sideling Hill tunnel in Huntingdon county, Pennsylvania.

The number is small. Excepting those of the New River group and of Lewis Tunnel, we have only from this geological division *Sphenopteris flaccida*, *Archæopteris obliqua*, *A. obtusa*, *A. minor*, *A. Halliana*, *A. hybernica*, *A. Rogersi*, *Rhacophyllum truncatum*, *Lepidodendron corrugatum*. Of these we may consider the *Archæopteris* as Devonian or Catskill types, for *A. minor* was obtained in numerous specimens from the Catskill red shale of Tioga county, Penn'a, by Mr. Sherwood, and *A. obtusa* is from the same formation at Montrose, Penn'a; *Sphenopteris flaccida* is a type of the Old Red of Europe. *Rhacophyllum truncatum* is comparable to *Cyclopteris Brownii*, which, with *Lepidodendron corrugatum*, is Devonian in Canada. None of these species are found either identical or by analogous form in the Sub-conglomerate, except *Archæopteris Halliana and Lepidodendron corrugatum.*

Taking separately the plants of the New River formation which Prof. Fontaine considers as partly devonian, continued into the Pocono* we have: *Alethopteris Helenæ* most abundant; *Megalopteris Dawsoni, Sphenopteris obtusiloba, Sphenophyllum antiquum, Archæopteris Halliana.*

Of these plants *Alethopteris Helenæ* is the more common species of the Sub-conglomerate of Alabama, also abundant in Arkansas and in the shale of the Jackson coal of Ohio. *Megalopteris Dawsoni* is apparently a narrow leaved form of *M. Hartii*, described by Prof. Andrews from the upper Waverly group of Ohio. *Sphenopteris obtusiloba* or *S. acuta* is a sub-conglomerate and carboniferous species. These, with *Sphenophyllum antiquum* and *Archæopteris Halliana*, completing the list of the plants of the New River group are all named in the list given here below of the plants from the Conglomerate of West Virginia.

Prof. Fontaine refers also to the New River formation the few plants described by Prof. Meek from the Lewis Tunnel; *Pseudopecopteris Virginiana*, a species closely allied to, perhaps a mere variety of *P. speciosa* of the Sub-conglomerate of Alabama. *Triphyllopteris Lescuriana*, a beautiful form intermediate between *Archæopteris Bockschiana*, sub-conglomerate in Pennsylvania, and *Eremopteris*, a genus of which all the species are sub-conglomerate or carboniferous, *Lepidodendron Scobiniforme*, described as *Stigmaria minuta* from the upper Red shale below Pottsville or from near the base of XII. Then *Archæopteris Alleghanensis* which identified with *A. Roemeri* is a lower or Pocono type.† This small group of plants has therefore a more ancient character than that of the Sub-conglomerate to which it is however allied by identity or close affinity of all its species except one.

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* He says as conclusion, Am. Jour. Sci., 3d ser., vol. VII, p. 579. It would then seem that the great expansion of the conglomerate of New River is not an isolated phenomenon, but that it is the effect of a condition of things which began in much older formations and continued until a later era.

† Prof. Fontaine, who has visited the locality, still mentions as seen there: *Neuropteris flexuosa* a carboniferous species, perhaps taken for *N. subfalcata* of the Alabama Sub-conglomerate, and *Archæopteris obtusa* a Devonian one. But he remarks that he had only time to collect a few plants which he has not had opportunity to study thoroughly, (*ibid. p. 578.*)

We have now for comparison the plants of the Conglomerate Series of West Virginia quoted and partly described by Prof. Fontaine, as follow:

Sphenopteris Hœninghausii, *Calamites Roemeri*, ? *Lepidodendron selaginoides*, *Sphenopteris adiantoides* and *macilenta*, *Bornia radiata*, *Odontopteris gracillima*, *Callipteridium rugosum*, *Cordaites Robbii*, ? *Alethopteris Helenæ*, *Calamites Cannæformis*, *Alethopteris grandifolia*, *Neuropteris Smithsii*, *N. tenuifolia*, two species of undescribed *Sphenopteris*; *S. spinosa*, an *Equisetitites*, *Asterophyllites acicularis*, *Trigonocarpus trilocularis*, *Megalopteris Hartii* and another species provisionally named *M. Swelleni*, *Sphenopteris obtusiloba*, *Archæopteris Halliana*, *Sphenophyllum antiquum*, *Odontopteris Newberrii*, and *Calamites approximatus*.

This list is a good abridged synopsis of the flora of the Sub-conglomerate, all the species except *Archæopteris Halliana* being true sub-conglomerate or lower carboniferous; for *Sphenophyllum antiquum* Daws. is an uncertain species described by the author from a single lobe, and determined also by Prof. Fontaine from a mere fragment of a lobe, and *Asterophyllites accicularis* is referable to *Calamites ramifer*, a sub or intra-conglomerate species, whose leaves are similar to those of *Asterophyllites foliosus* to which Schimper compares *A. acicularis*. *Calamites Roemeri* and *Cordaites Robbii* are quoted by Prof. Fontaine as doubtful.

As remarked already, all the species of New River are mentioned in the above list, and though the species are few, as none of them have the characters of an inferior group or any devonian type, it is scarcely possible to admit the New River formation as older than the Sub-conglomerate, whose flora is distinctly characterized.

§ 51. This sub-conglomerate flora is represented by one hundred and five species, of which forty-five exclusively pertain to it. It has none of the older types, except those quoted from New River; among them *Archæopteris Hal-*

liana, which pass up to the Upper Waverly Sandstone of Ohio.

Of species continued upwards to more recent strata, it has nine in the Intra-conglomerate, twenty-two in the lower division of the true carboniferous coal A, B, C, and eighteen passing still higher to coal E, besides eighteen which represented in the whole thickness of the coal measures, are common species, and may be eliminated from any comparison made on the stratigraphical distribution. As seen upon the table where they are indicated by an horizontal line, none of them appear lower than the Sub-conglomerate. It is therefore from this well determined geological division that the more important and more numerous typical forms of the vegetation of the Carboniferous have had their origin.*

Stratigraphical determination places into this Sub-conglomerate a peculiar bed of shale discovered in the upper part of the Waverly Sandstone of Ohio, near Rushville, by Prof. E. B. Andrews. This shale has furnished, especially *Megalopteris* species and some others, described and figured by Prof. Andrews, which have not been found in any part of the productive Coal-measures. The same formation also barren of coal has been observed near Port Bryon, Ill., as recognized by plants which are of the same type. At this last locality the horizon of the shale could not be positively ascertained, it was merely indicated as in the lowest strata of the Carboniferous of that country.

The originality of the characters of these plants, their dissimilarity from the types of the other carboniferous species, either American or European, may be explained in supposing that there was already at the coal epoch a land flora distinct in its characters from that of the swamps forming coal, as is now the flora of the peat bogs, and that its remains being rarely preserved are still mostly unknown to us. Except two species of *Megalopteris* found in Canada and W. Virginia and *Archæopteris Halliana*, all the species of this isolated formation are peculiar and limited to it. They are indicated upon the fourth column by letter M.

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* Only three species are known from the Mauch Chunk red shale XI. The proper place of the group is, therefore, undefined.

§ 52. The intra-conglomerate plants are marked upon two divisions of the fourth column, the left side for those of the bituminous coal measures, the other for the anthracite.

The whole group has one hundred and sixty-seven species, thirty of which are peculiar to it. Twenty-nine of these are found in both the anthracite and the bituminous, four of them limited to the group; thirteen are also in the Sub-conglomerate, especially in that of W. Virginia, and twenty-five pass above, especially to the lower strata, A to C, of the true Carboniferous.

This group is remarkable for its abundant remains of fructifications found mostly at Cuyahoga Falls, Ohio, and under the Campbell's ledge of Pittston. At Cuyahoga Falls the seeds are associated with *Ferns*, especially *Alethopteris grandifolia*, *Lepidodendron Veltheimianum*, three species of *Sigillaria* and *Whittleseya elegans*, while under the Campbell's ledge of Pittston, they are found with few Ferns, *Calamites ramifer*, two species of *Spirangium*, *Lepidodendron Veltheimianum* and two species of *Cordaites*. Some of these numerous seeds are hypothetically referred to *Whittleseya* and to *Cordaites;* others to *Lycopodiaceæ*.

The Coal beds of Youngstown are identified with those of Cuyahoga Falls by the presence in both of some identical species, by the abundance of seeds and by the affinity of types. But until now I have not obtained sufficient materials in plant remains from the Coal beds of Sharon to know if they are referable by their vegetation to the intra-conglomerate or the sub-conglomerate measures.

Most of the specimens seen from around Sharon represent *Lepidodendron* and *Sigillaria* species, with few fruits. These remains agree in characters with those of the upper coal of Tennessee, the Sewanee mine, which, with *Alethopteris Serlii*, *A. lonchitica* and *Asterophyllites grandis*, has five species of *Sigillaria* and five of *Lepidodendron*.

The Ætna vein of Tennessee, however, with *Sphenopteris tridactylites*, *S. Hildreti*, *S. furcata*, three species of *Lepidodendron* and three of *Trigonocarpus* has its place in the Sub-conglomerate. Therefore, the upper coal of Tennessee, like that of Sharon, may be intermediate to one of the members of the Conglomerate, XII.

§ 53. It is from the lower coal beds of the true Carboniferous, or from Coal A, the first above the Conglomerate, that we have the more numerous and more important data.

Sometimes two, even the three of the lower coal beds of the Productive Carboniferous, A, B, C, of Lesley's manual are close to each other, even united in one, and for this reason have been indicated in the Reports of the Geol. Survey of Kentucky, by D. D. Owen, as 1*a*, 1*b*, 1*c*. For in Kentucky, Coal 1*c* is either the third bed above the Conglomerate, or the second, even the first, by connection with one or the two lower. It is generally a cannel coal, or pass at short distances from cannel to bituminous, in such a way that sometimes cannel coal is taken out at one side of a mine, and bituminous coal at the other.

It is now questionable if the lower coal strata of Illinois seen at Mazon creek, Morris, Murphysborough, and Colchester, can be identified by concordance of vegetation with the Clinton coal of Missouri and the Cannelton coal of Pennsylvania, from which we have abundant vegetable remains for comparison.

Of the plants exclusively found in connection with each of these coal beds, Mazon creek has eighty, Morris twenty-three, Murphysborough nine, Colchester five. The geological station of these four localities is identified by stratigraphy as well as by the analogy of their flora, as seen upon the table. We have therefore for comparison, taking all the plants peculiar to the same horizon in Illinois, one hundred and seventeen species. Of these Cannelton has fifty-six, besides its thirty-eight proper species and Clinton twenty-eight, with eighteen proper species. The relation is thus so intimately marked that if it is not possible to admit the strata as synchronous, it is at least necessary to consider them as pertaining to a same group quite as distinct in the characters of its flora as is the Sub-conglomerate. This group corresponds to A B C of the anthracite and if for future reference called Group A. The species discovered in it amounting already to three hundred and twenty.

§ 54. The Coal strata coming after in the ascending order appear to correspond to the horizon of the Upper Freeport of Pennsylvania or Coal 6 of the Ohio, Indiana and Illinois sections.

Of this horizon we have so few materials that it is not yet possible to present points of comparison between the localities where the few plants have been obtained and to relate them to upper or lower strata. Possibly Coal 1 of Olyphant marked Go on the third column of the Anthracite side of the table may be referable to this horizon. But as yet the coal strata have only three species in common. That the flora is a middle one and has distinct characters is indicated by its species.

Those not found elsewhere: *Rhacophyllum inflatum*, *Stemmatopteris insignis*, *Lycopodites Ortoni*, *Lepidodendron forulatum*, *L. Tyjoui*, *L. radicans*, *Halonia secreta*, *Lepidoploios auriculatus*, *Cardiocarpus bicornutus*, are, with few exceptions, of peculiar types, as also *Pseudopecopteris spinulosa* which was found at Duquoin first, and of which small specimens have been obtained in the Anthracite of Rhode Island. The other species of the group are related nearly in equal number to the flora of the lower and to that of the upper strata.

§ 55. The upper division of the coal, including the bed marked in the anthracite measures as M, in the bituminous as G, constitutes a distinct group, though like the former its flora is not yet represented by sufficient materials.

The number of species known from it is seventy-eight, besides five marine Algæ. Of this number thirty-four are proper to the group, eighteen in the anthracite, eleven in the bituminous measures, three being found in both. The others, forty-four in number, are diversely distributed mostly in the whole thickness of the true coal measures, as are generally the common species found everywhere.

The more distinct relation is with Morris and Mazon creek by seven species, with Cannelton by seven also, and with Rhode Island by four; a dozen of these are present in two or three localities: Mazon Creek, Morris, Cannelton, Clinton, etc., while besides the three mentioned above, ten are present both in the anthracite and the bituminous.

§ 56. The anthracite bed of Rhode Island is still left for consideration. Do the plants obtained from it indicate its geological station? We have from the coal twenty-seven species, three of which only are proper to it; of the others, twenty are identified in the group A. Though a number of them are of wide distribution, the reference of the coal of Rhode Island to the lower group A seems positive, so far as one may rely on evidence based on such scanty materials.

CHAPTER VII.

On the origin, succession, and modifications of the vegetable types, from the base of the Coal Measures upwards.

§ 57. Though the evidence is not admitted by all the phytopalæontologists as entirely satisfactory, it seems proved that the types of the primary divisions of the coal flora are represented already in the upper, even from the middle of the Silurian.

Remains of *Calamariæ* have been described as *Sphenophpllum primævum*,[*] from the Cincinnati group, and as *Annularia Ræmingeri*, from the Lower Helderberg sandstone of Michigan.[†]

As yet, no remains of Ferns are known from the Silurian of this Continent; but Saporta has described and figured under the name of *Eopteris Morieri*,[‡] a remarkably well preserved branch of a Fern closely related by its character to the *Nephropterid* section of the genus *Neuropteris*. This Fern was discovered in the Schistes of Angers, a formation whose age apparently corresponds to that of the Cincinnati group.

Of the *Lycopodiaceæ*, Prof. Dawson has found remains of *Psilophyton* and *Selaginites* in the Upper Silurian of Canada,[§] and Prof. Claypole has described a silurian *Lepidodendron* from Ohio.[‖]

Of the *Sigillariæ*, fragments of a stem is described and figured as *Protostigma Sigillarioides* from the Cincinnati group.* A larger fragment of a well-defined *Sigillaria*, *S. Hausmanni*, Goepp., found in the lowest strata of the Devonian of Scandinavia sufficiently proves the presence of the genus in the Silurian.

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[*] On Silurian Plants, by L. Lesquereux. Proc. Am. Phil. Soc., VII, v, p. 167.

[†] Ibid., p. 166.

[‡] Saporta. Le monde des plantes, p. 35, Pl. I.

[§] On the pre-Carboniferous flora, etc., Canadian Naturalist, May, 1861, p. 16.

[‖] Geol. Magaz. Decade II, No. 12, 1878.

Of the *Cordaites*, remains of *C. angustifolius* are represented with descriptions by Prof. Dawson,† from the Upper Silurian of Canada.

In ascending the Series of the formations, the remains of land plants, all referable to the same divisions of the vegetable reign, become more numerous, also better preserved and more positively determined, so that, from the middle Devonian, Prof. Dawson already describes two species of *Calamites*, a *Cyclopteris incerta*, which, from the branch representing the fructification, is like a species of *Archæopteris;* a *Psilophiton*, two species of *Lepidodendron*, a *Sigillaria*, a *Didymophyllum*, and three *Cordaites.*‡

In the Catskill and the Chemung above, with species of *Lepidodendron*, *Sigillaria*, *Calamites*, and *Cordaites*, the Ferns are more abundantly represented by *Archæopteris* species, a peculiar and distinct type which pass to *Adiantites* and *Sphenopteris*, soon losing its identity. For the last traces of *Archæopteris* are seen in the middle of the Sub-conglomerate, or at the horizon of the Chester limestone.

It is at this horizon, or in the middle of the Sub-conglomerate, that appear two essential and more predominant and persistent types of the *Neuropteris;* the first in *N. tenuifolia*, *N. Loschi;* the second in *N. hirsuta*, which, both continued by identity and derivation, are abundantly distributed in the whole thickness of the Carboniferous, and higher up to the Permian.

Here also we find in their admirable luxuriance the *Megalopteris*, an isolated and peculiar type of Ferns, whose species, by the forking of the medial nerve of their leaves and by their venation, have left trace of their existence only in the more recent *Neuropteris fascieulata*. The type does not appear to be derived from a more ancient one. A species is quoted by Prof. Dawson in the Devonian of Canada; all those described in this flora are from the horizon mentioned above, that of the Chester limestone or the upper part of the Waverly group.

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* On Silurian Plants; by L. Lesquereux, loc. cit., p. 169.

† Canadian Naturalist, May, 1861, pp. 10, 16.

‡ Quater. Journ. Geol. Soc., 1862, p. 298.

I have remarked already that it may be a representative of the land flora of the Carboniferous age. We have, indeed with it, plants which, without anteceding relatives are also limited in their distribution to the same formation—*Lesleya grandis*, one species of *Orthogoniopteris*, *Danæites macrophyllus*, *Protoblechnum Holdeni*, *Eremopteris marginata*, *Hymenophyllites Balantini*, and a true *Polypodium*, not described by Prof. Andrews, but which, from the specimens examined (fragments of fruiting linear narrow leaves) could be admitted as representing one of the numerous varieties of the living *P. angustifolium* Sw. of Cuba.

§ 58. The order of the *Equisetaceæ* (quite as distinct at the beginning of the coal period as it is at our time) is limited to four types. of characters very difficult to fix, and scarcely modifiable. Of the *Equisetites* the U. S. Coal flora has merely a few sheaths. Of the *Calamariæ*, the *Calamites* are present in the lower Devonian as well as their branches, the *Asterophyllites*, and are distributed through the whole thickness of the coal measures ascending to the Permian. The same remark applies to *Annularia*. *Sphenophyllum*, more distinctly characterized, not merely as a genus, but in its different species, has a wide distribution. Present in the Silurian and the Devonian, it is in the Sub-carboniferous in three species, and after, by an abundance of its remains, it shows its passage through all the strata of the Coal-measures to the Permo-carboniferous, where it disappears entirely.

Bornia and *Calamodendron* are known as yet by mere fragments, their relation to the *Calamariæ*, or to a higher order of plants is still unascertained.

§ 59. In the Ferns, the genus *Neuropteris* is the more remarkable by the elegance and size of its fronds and leaves. The type may be derived, as well as that of the *Megalopteris* and of the *Archæopteris* from the silurian *Eopteris;* but the genus itself is limited in its characters, which though variable, are always distinct. The group of the *Cyclopterids* and that of the *Neuropteris* proper are represented in the Devonian from which Prof. Dawson has described *Cyclopteris varia* and *Neuropteris polymorpha* allied to *N. angustifolia.* This last type especially has numerous representatives through the whole thickness of the coal measures in *N. hirsuta*, *N. cordata*, *N. Loschii*, *N. tenuifolia*, all species present in the Sub-conglomerate, most abundant in the upper Carboniferous, passing higher to the Permian. *N. hirsuta* and *N. Loschii* fill whole strata of soft sandstone or black shale at the horizon of the Pittsburgh and the Pomeroy coal. *N. fimbriata* and *N. inflata* have the same distribution from the Sub-conglomerate, but as yet have not been seen above the Carboniferous.

The species mentioned above represent the section of the thin veined *Neuropteris;* a sub-division of the same group, that of the coarse veined species, includes *N. Clarksoni*, *N. Desorii*, *N. rarinervis*, *N. vermicularis*, all commonly represented in the true Carboniferous. The first of these species, only, is found in the Sub-conglomerate measures.

The genus *Odontopteris* is mixed in its characters and its distribution. It is derived for some of its species from *Neuropteris*, and allied by others to *Sphenopteris.* Its distribution is from the Sub-conglomerate to the Permo-carboniferous and the Permian. No species of *Odontopteris* are described from the Devonian of Canada.

Dictyopteris is nearly identical in its characters with *Neuropteris.* Of the two species described, one, from the lower Carboniferous, represents the section of the *Nephropterids;* the other, related to the *Neuropterids* proper, especially to *N. Loschii*, is, like this species, distributed through all the stages of the coal measures, from the Sub-conglomerate to the Permo-carboniferous.

From the *Neuropterids* we pass to the *Alethopterids* by *Lescuropteris* and *Callipteridium.* These two genera are allied to the *Neuropteris* by the venation, and to *Alethopteris* by the ramification, the mode of division of the fronds and the shape of the leaflets. The fructifications of *Callipteridium* are scarcely known, for the only fructified fragment referred to the genus, that of *C. inflatum*, is too small to allow a deduction on the characters of the fructifications of the group. Species of this genus have been referred by authors to *Neuropteris*, *Alethopteris* or *Callipteris.* The two species of *Lescuropteris* are limited to the upper Carboniferous; of *Callipteridium*, three species are in the Sub-conglomerate, the habitat of the others (except one) is limited to the lower Carboniferous A, B, C.

Alethopteris has in Canada one devonian species; four are exclusively sub-conglomerate in the United States coal measures; of the others four ascend to the upper Carboniferous. The genus is represented also in the Permo-carboniferous and the Permian.

The type is not sufficiently allied to the *Neuropterids* to indicate a distinct derivation through the genus *Callipteridium.* It rather seems to be an original one, anteceding and foreboding the great division of the *Pecopterids.* Its fructifications as far as known by *A. Gibsoni* are marginal like those of the living *Pteris aquilina* to which Brongniart compares the genus.

For *Alethopteris*, as for some other groups of plants of the Carboniferous, the original species or those nearer to the point of origin are the largest, more fully developed than the descendants. Thus we pass from the large-leafed *Alethopteris discrepans* of the Devonian, *A. maxima* and *A. grandifolia* of the Sub-carboniferous to *A. Serlii*, *A. lonchitica* of Coal A, B, C, then to *A. ambigua* reduced in size, ascending to the upper coal and then to *Pecopteris.* The same decline is marked from the *Megalopteris* to the *Neuropteris*, *Dyctyopteris*, etc.

The genus *Pseudopecopteris*, composed of species closely allied together, distantly related to *Alethopteris* and *Sphenopteris*, is altogether a peculiar group, not less distinct in its characters than in its distribution. All the species, except three, indifferently referred to the genus, inhabit the Sub-conglomerate and the lower Carboniferous.

The genus *Pecopteris* has in the U. S. Coal measures a single representative below the Conglomerate, *P. angustissima*, a rare form here as in Europe. A few species of the genus, some of the division of the *Goniopteris*, and most of those of the *Crestate* and *Villous* groups, have their habitat limited to coal A. But generally the genus *Pecopteris* is more abundantly distributed and more diversified in the upper Coal measures. The common species, *P. arguta*, *P. oreopteridis*, *P. platyrachis*, *P. dentata*, *P. elliptica*, *P. Miltoni*, pass upwards to the Permo-carboniferous, even to the Permian. The two last species, with *P. arborescens* and *P. nodosa* are not found lower than the middle coal E.

The *Sphenopterids* are Sub-conglomerate or lower Carboniferous; very few of them pass above the middle coal E. A peculiar group of this genus allied to *Pecopteris* appears in the Permo-carboniferous and is limited to that horizon.

The genus is diversified in its types; some of them appear to be original. *S. Hœninghausii*, Brgt., one of the more abundant species of the Sub-conglomerate, already present in the Devonian of Canada, is represented here as in the Culm of Europe by a number of closely allied forms, mostly composing the group of the *Hymenophyllites*. *Eremopteris* and *Triphyllopteris*, separated by Schimper from *Sphenopteris*, are evidently derived from *Archæopteris*, having also the same distribution, all in the Sub-conglomerate or still lower.

The trunks of Fern trees, *Stemmatopteris*, *Caulopteris*, *Psaronius*, *Megaphytum*, rare in Europe, are in the U. S. Coal-measures, if not abundant, at least often found in the lower and middle Carboniferous. Three species are mentioned in the Devonian of Maine, none from the U. S. Sub-conglomerate.

Silicified remains of *Psaronius* and of other Fern trees abound at the horizon of the Pomeroy coal of Ohio.

§ 60. The *Lycopodiaceæ* of the coal, known mostly in their fossil state by remains of trunks and branches, compose an original group which, though very distinct, is much diversified in its character.

The oldest plants of this order traced in the Silurian belong to *Lepidodendron* and to *Psilophiton*. The distribution of this last genus seems limited to the Lower Devonian.

A few fragments of *P. princeps* have been found in the Devonian of Maine; none have been seen in the U. S. Coal measures. The characters of the genus are not yet fully defined.

All the *Lycopodiaceæ* have the same essential characters and therefore appear derived from a same stock. From the Devonian, where, in the U. S., seven species have been found already, they rapidly increase in the number of their representatives, becoming most predominant at the horizon of the Conglomerate, where the coal strata under and above this formation are mostly composed of their remains. From the third Coal *C* upwards they follow a contrary and quite as rapid movement of decadence, so that very few *Lycopodiaceæ* are recorded from the middle Carboniferous. One species only is referable to the upper strata. It is a branch of a peculiar *Lycopodites*, *L. strictus*, found near New Harmony, Indiana, in the shale of a coal bed whose horizon is not positively ascertained.

§ 61. The *Sigillariæ*, known like the *Lycopodiaceæ*, merely by remains of trunks, and characterized by the scars left upon the bark at the points of attachment of the leaves, constitute also a well-defined group, whose relation, however, to plants living at the present epoch is far from being ascertained. They are also evidently derived from a single ancestral stock, already recognized in the Silurian. A few species have been discovered in the Devonian of this Continent; three of them are described by Prof. Dawson, from this formation in Maine and New York State. We have in the flora six Sub-conglomerate species. In the Lower Carboniferous, the number is greatly increased, but they are there in a far less proportion than *Lepidodendron*, which *Sigillaria* gradually replaces, becoming mostly predominant in the middle Carboniferous, and continuing in a limited degree into the Permo-carboniferous and the Permian.

Stigmaria has a far more general distribution than *Sigillaria*. Its remains abound everywhere as well in the Sub-conglomerate as in the true Carboniferous. The are of less frequent occurrence in the Permian.

§ 62. The *Cordaiteæ* are also an original group distinctly limited in its characters and generally distributed from the Devonian to the Permian, most abundant at some peculiar localities, but without distinct predominance in regard to stratigraphical distribution. Their relation to plants of our time is, like that of the *Sigillariæ*, still uncertain. They belong, evidenly, to the Gymnosperms, and, as remarked in the description of the order, are considered by Renault as related essentially to the *Cycadeæ*.

Accepting this conclusion, I may repeat now with entire confidence an assertion somewhat hypothetically expressed years ago: that until now no trace of the Conifers have been seen in the U. S. Coal-measures. The first and only coal plants which may be referred to Conifers are the *Salisburiæ* (the Ginkgo). *Whittleseya* seems more distinctly related to *Cordaites*, but may be an intermediate type; while, evidently, *Saportea* and *Baiera* of the Permo-Carboniferous* belong to the *Salisburiæ*. But even these *Salisburiæ* are not true Conifers; they constitute a separate group which, distinct in its characters and preserving its identity, has passed from the base of the Permian through the whole series of the Geological formation, homogeneous, unmixed by the intrusion of foreign elements. This group has certain characters in common with the Conifers, but it differs essentially by its inflorescence, fructification, and foliage. The true Conifers, with fruits in catkins, appear later in the Permian, by the *Walchiæ*. None of them has been found in the U. S. Coal measures.

§ 63. The reference of the numerous fruits and seeds described in the Flora is not positively ascertained. A number of them are evidently mere capsules or sporanges, containing seeds of *Lycopodiaceæ*. Others are recognized as pertaining to the *Cordaites;* authors ascribe a number of them to *Sigillaria*. In their distribution they essentially range like the *Lycopodiaceæ* from the Sub-conglomerate to the middle Coal E, mostly under, within, and immediately above the Conglomerate measures.

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* Rep. PP, Permian flora, pp. 101, 103.

LITERATURE OF THE U. S. COAL FLORA.

Andree, (R.) Versteinerungen d. Steinkohlen Gebirge, von Stradonitz, Böhmen.

Andrews, (E. B.) Descriptions of Fossil Plants from the Coal Measures of Ohio. (Rept. of the Geol. Survey of Ohio, Paleontology, vol. ii, 1875.)

Elementary Geology, (1878.)

Auerbach, (J.) Notiz über einige Pflanzenversteinerungen aus einem Sandsteine des moskovit Governement. (Bullet. de la Soc. Imp. des naturalistes de Moscow. 1844.)

Artis, (Ed. Tyrell.) Antediluvian Phytology. London, 1825.

Balfour, (John Hutton.) Introduction to the study of Palæontological Botany. Edinburg, 1872.

Berger, (Reinh.) De fructibus et Seminibus ex formatione lithanthracum. Vratisl., 1848.

Binney, (E. W.) Remarks on *Sigillaria* and some spores found imbedded in the inside of its roots. (Quat. Jour. Geol. Soc., 1859.)

On *Sigillaria* and its roots. (Trans. Manchester Geol. Soc., 1860–61.)

A description of some fossil plants showing structure, found in the lower Coal seams of Lancashire and Yorkshire. (Philosoph. Trans., vol. x, Mvccclxv.) London, 1865.

Observations on the structure of Fossil Plants found in the Carboniferous strata. Part I, *Calamites and Calamodendron*, 1868; Part II, *Lepidostrobus*, and some allied cones, 1871; Part III, *Lepidodendron*, 1872; Part IV, *Sigillaria* and *Stigmaria*, 1875. (Palæontographical Society of London.)

Brauns, (D.) Der Sandstein by Seinstedt unweit des Fallsteins und die in ihm vorkommenden Pflanzenreste. (Palæontographica, vols. ix and xiii.)

Brongniart, (Ad.) Prodrome d'une histoire des végétaux fossiles. (1828.)

Histoire des végétaux fossiles ou recherches botaniques et Geologiques sur les végétaux dans les diverses couches du Globe, 1828–1844. (15 fasc.; work not finished.)

Memoire sur la relation du genre *Noeggerathia* avec les plantes vivantes. (Ann. Sci. Nat., 1833.)

Observations sur la structure intérieure du *Sigillaria elegans*, comparée à celle des *Lepidodendron* et des *Stigmariæ* et à celle des végétaux vivants. (Archives du Museum, vol. i.) 1839.

Tableau des genres des végétaux fossiles considérés sous le point de vue de leur classification botanique et de leur distribution géologique. (Extrait du Dictionnaire universel d'histoire naturelle.) 1849.

Etudes des graines silicifiées du Terrain Houiller de Saint-Etienne. (Ann. d. Sci. nat. 5e series, vol. xx, 1878.)

Bunbury, (Ch. I. F.) Description of an upright *Lepidodendron* with *Stigmaria* roots, in the roof of the Sidney Main Coal, in the Island of Cape Breton. (Quat. Journ. Geol. Soc., 1847.)

On erect *Sigillariæ* with conical tap roots, found in the roof of the Sidney Main Coal. (*Ibid.*, 1849.)

On a particular Fossil Fern from the Sidney Coal-field, Cape Breton. (Quat. Jour. Geol. Soc., 1852.)

On fossil plants from the Coal formations of Cape Breton. (*Ibid.*, vol. iii.)

Claypole, (E. W.) On the occurrence of a Fossil Tree (*Glyptodendron*) in the Clinton limestone. (Geol. Mag., Dec. 2, vol. V, 1878.

Coemans (Eug.) et Kickx, (J. J.) Monographie des *Sphenophyllum* d'Europe. (Bull. de l'Acad. roy. de Belgique, vol. xviii.) 1864.

Corda, (A. C. J.) Beiträge zur Flora der Vorwelt. 1845.

Crépin, (François.) Fragments paléontologiques pour servir a la Flore du Terrain Houiller de Belgique. (Bull. de l'Acad. Roy. d. Belgique, 2d series, vol. xxxviii.) 1874.

Description de quelques plantes fossiles de l'étage des Psammites du Condroz. (*Ibid.*) 1874.

Dawson, (J. W.) Acadian Geology, 1855; Supplement, 1860. Second edition, 1868; third edition, 1878.

On fossil plants, from the Devonian Rocks of Canada. (Quat. Journ. Geol. Soc. of London.) 1859.

On the Pre-Carboniferous Flora of New Brunswick, Maine, and Eastern Canada. (Canadian Naturalist for May, 1861.)

On the Flora of the Devonian Period in North-Eastern America. (Quat. Journ. Geol. Soc., vol. xviii.) 1862.

Further observations on the Devonian Plants of Maine, Gaspé, and New York. (*Ibid.*, vol. xix.) 1863.

On the conditions of the Deposition of the coal, more especially illustrated by the Coal Formation of Nova Scotia and New Brunswick. (*Ibid.*, vol. xxii.) 1866.

On the Structure and Affinities of *Sigillaria*, *Calamites*, and *Calamodendron*. (*Ibid.*, vol. xxvii.) 1871.

On new Tree Ferns and other Fossils from the Devonian. (*Ibid.*, vol. xxvii.) 1871.

The Fossil Plants of the Devonian and Upper Silurian Formations of Canada. (Geol. Survey of Canada.) 1871.

Report on the Fossil Plants of the Lower Carboniferous and Millstone Grit Formations of Canada. (*Ibid.*) 1873.

On a specimen of *Diploxylon* from the Coal Formation of Nova Scotia. (Quat. Journ. Geol. Soc., November, 1877.)

Notes on some Devonian Plants. (Canad. Naturalist, vol. viii, No. 7.) 1872.(*)

---

*Of others works not quoted in the U. S. Coal Flora Prof. J. W. Dawson has published.

Notes on an erect *Sigillaria* and a *Carpolites*. (Quat. Journ. Geol. Soc., vol. x, 2, 6.

Dawes, (J. S.) Remarks upon the internal structure of *Halonia.* (Quat. Journ. Geol. Soc., 1847.)

Eichwald, (E.) Lethæa rossica on Paléontologie de la Russie. 3 vols., 1852–1869.

Ettingshausen, (C. v.) Beiträge zur Flora d. Vorwelt. (Natur. Abhandl. v. Haidinger, vol. iv, 1851.)

Die Steinkohlen flora von Stradonitz in Böhmen. (Abhandl. der Geol. Reichsanstalt, 1852.)

Die Steinkohlen flora von Radnitz in Böhmen. (*Ibid.*, 1854.)

Ettingshausen, (C. v.,) and Debey. Die urweltlichen Acrobryen d. Kreidegebirgs von Aachen und Mästricht. (Denk.-An. d. K. K. Akad. d. Wissensch., Vien, 1857.)

Feistmantel, (Oscar.) Steinkohlen flora von Kralup in Böhmen. (Abhandl. d. K. Böhm-Gesellsch d. Wissensch., vi, Vien. 1871.)

Fiedler, (H.) Die fossilen Fruchte der Steinkohlen formation Breslau, 1854.

Fairchild, (Herman L.) On the variations of decorticated leaf scars of certain *Sigillariæ.* (Annals of the New York Ac. of Sci., vol. i, No. 2, 1877.)

On the variations of leaf scars of *Lepidodendron aculeatum*, St. (*Ibid.*, No. 3, 1877.)

On the identity of certain supposed species of *Sigillaria* with *S. lepidodendrifolia*, Brgt. (*Ibid.*, No. 5, 1878.)

Fontaine; (W. F.) Species of fossil plants described or mentioned in the Great Conglomerate on New River, West Virginia. (Am. Jour. Sci., third series, vol. vii, 1874.)

The Conglomerate Series of W. Virginia. (*Ibid.*, vol. xi, 1876.)

Notes on the Vespertine Strata of Virginia and West Virginia. (*Ibid.*, vol. xiii, 1877.)

Synopsis of the Flora of the Carboniferous Period. (Can. Naturalist, 1863.)

The vegetable structures in Coal. (Quat. Journ. Geol. Soc., vol. xv.) 1860.

Report on Prince Edward's Island. (Plants of Permo Carboniferous, 1871.)

On spore-cases in coal. (Am. Journ. Sci. & Arts, 1871.)

On Carruther's views of *Prototaxites.* (Monthly Micr. Journ., 1873.)

On the Upper Coal Formation of Nova Scotia. (Fossil plants, 1874.)

On New Devonian plants. Proc. Geol. Soc. of London, 1880.)

Fontaine, W. F., and I. C. White. The Permian or upper carboniferous Flora of West Virginia. (Sec. Geol. Surv. of Pennsylvania, Rept. PP.)

Geinitz, (H. B.) Die Versteinerungen der Steinkohlen formation in Sachsen. Leipsig, 1855, fol.

Die Zechstein formation u. d. Rothliegende. Berlin, 1861.

Germar, (E. F.) Versteinerungen des Steinkohlengebirgs von Wettin u. Löbejün. Halle, 1844.

Germar u. Kaulfuss, ueber merkwurdige Pflanzenabdrücke, a. d. Steinkohlen formation. (Nova Acta nat. Curios., 1831.)

Goldenberg, (F.) Flora Sarræpontana fossilis, 3 livr., fol. Saarbrucken, 1855–1862.

Goeppert, (H. R.) Systema Filicum fossilium. (Nova acta Acad. Cæsareæ Leop. natur. Curios. suppl., vol. xvii. Breslau, 1836, 4°.)

De Coniferarum Structura Anatomica. (1841.)

Die Gattungun der fossilen Pflanzen. Bonn., 1841–48. Fasc. 1–6, 4°, not finished.

Monographie der fossilen Coniferen. (Naturk. Verhand. Haarlem II, Deel 6, Leyden, 1850, 4°.)

Die fossile Flora des Uebergangsgebirges. (Nova acta Acad. Cæsareæ Leop. nat. Curios., vol. xxii, suppl., Breslau, 1852, 4°.

Die fossile Flora der Permischen Formation. Cassel, 1864–1865, 4°.)

Grand'Eury, (Cyrille.) Flore carbonifère du Département de la Loire et du Centre de la France. Paris, 1877, 4°.

Granger, (E.) Notice of Vegetable Impressions on the rocks connected with the coal formation of Zanesville, (Ohio.) (Amer. Journ. of Sc., vol. iii.)

Gntbier, (A. V.) Abdrucke u. Versteinerungen des Zwickaur Schwarzkohlengebirges u. seiner Umgebungen. Zwickau, 1842.

Die Versteinerungen des Rothliegenden in Sachsen. Dresden u. Leipsig, 1849.

Hall, (James.) Natural History of New-York, (Palæontology.) Albany, 1852, 4°.

Contributions to Palæontology, (Flora of the Devonian Period.) Sixteenth Annual Report of the Regents of the University of New York. Albany, 1863.

Harlan, (Rich.) Description of an extinct species of fossil Vegetable, *Fucoides Allegheniensis.* (Acad. of Nat. Sci., Philadelphia, vol. vi, 1831.)

On *Fucoïdes Brongniartii.* (Amer. Jour. of Geol. & Nat. Sci., i, 1831.)

Notice of Fossil Vegetable remains from the Bituminous Coal Measures of Pennsylvania. (Trans. Geol. Soc. of Penn'a, i, p. 256.

Description of a new fossil plant from Penn'a. (*Ibid.*, i, p. 260.)

Heer, (Oswald.) Flora fossilis Helvetica. 4 vols., fol. 1855–1876.

Flora fossilis arctica. 5 vols., 4°. 1868–1878.

Fossil flora der Bären-Insel. (Kongl. Svenska Vedens-Kaps. Akad. Handl., ix, 1871.)

Hildreth, (S. P.) On the Bituminous Coal deposits of the Ohio Valley, with notes on fossil organic remains. (Amer. Journ. Sci., first series, vol. xxix, 1836.)

Notes from the diary of a naturalist on a tour to the falls of Cuyahoga, Ohio. (Am. Journ. Sci., first series, vol. xxxi, 1838.)

Hooker, (J. D.) On the vegetation of the Carboniferous Period, as compared with that of the present day. (Geol. Surv. of the United Kingdom, 1847.)

On a New Species of *Volkmannia.* (Quart. Journ. Geol. Soc., 1854.)

Hooker and Binney. On Trigonocarpous contained in bituminous nodules. (*Ibid.*, 1855.)

Lesquereux, (Léo.) New species of fossil plants from the Coal fields of Pennsylvania. (Boston Journ. of Nat. Hist., vol. vi, 1854.)

Fossil plants of the Coal strata of Pennsylvania. (In H. D. Roger's Geol. of Penn'a, 1858.)

Lesquereux, (Lèo.) The fossil plants of the Coal measures of the United States. Catalogue with description of new species. Pottsville, 1858.

Palæontological Report on the Flora of the Coal Measures of W. Kentucky. (D. Dale Owen Geol. Survey of Ky., vol. iii, 1857.)

Report of the fossil Flora and on the stratigraphical distribution of the coal in the Kentucky Coal fields. (*Ibid.*, vol. iv, 1861.)

Botanical and palæontological Report on the Geological State Survey of Arkansas. (Second Report on the Geol. of Ark., 1860.)

Enumeration of the fossil Plants found in the Coal Measures of Illinois, with descriptions of new species. (Geol. Survey of Ill., vol. ii, 1866.)

Fossil plants of the Main Sewanee Jackson Coal, etc., of Tennessee. (Geology of Tennessee, 1869.)

Report on the fossil Plants of the Illinois Coal fields. (*Ibid.*, vol. iv, 1870.)

On Fucoids in the Coal formations. (Trans. Am. Phil. Soc., vol. xiii, 1868.)

On species of Marine Plants from the Carboniferous measures. (Seventh Annual Rept. on the Geol. Survey of Indiana, 1875.)

Partial List of Coal Plants from the Alabama fields. (Geol. Survey of Alabama, 1876.)

Land plants recently discovered in the Silurian Rocks of the United States. (Am. Phil. Soc., Philadelphia, 1877.)

On *Cordaites* and their Generic Divisions in the Carboniferous formations of the United States. (*Ibid.*, 1878.)

On a branch of *Cordaites*, bearing fruit. (*Ibid.*, 1879.)

Lindley and Hutton. Fossil Flora of Great Britain. 3 vols., 8°. London, 1831–1837. New Ed., London, 1872.

Ludwig, (R.) Fossile Pflanzenreste aus der palæolithen Formation der Umgegend von Dellenburg, etc. (Paleontograph, vol. xvii, 1879.)

Meek, (F. B.) Descriptions of New Species of Fossil Plants from Allegheny Co., Virginia. (Bull. Phil. Soc. of Washington, 1875.)

Morris, (John.) Descriptive Catalogue of the Fossil Organic Remains of Plants contained in the College of Surgeons of England. 1855.

Newberry, (J. S.) Fossil plants from the Ohio coal basin. (Annals of Science, of Cleveland, Ohio, vol. i, Nos. 8 & 9, 1853.)

New Fossil Plants from Ohio. (*Ibid.*, Nos. 10, 13, 14, 1853.)

Structure and Affinities of certain Fossil Plants of the Carboniferous era. (*Ibid.*, No. 23.)

New species of Fossil Plants. (*Ibid.*, vol. ii, No. 1, 1854.)

Description of Fossil Plants from the Coal measures of Ohio. (Rept. of the Geol. Survey of Ohio, vol. i, Palæontology.)

Parkinson, (J.) Organic remains of a former World. London, 1808–1820.

Petzhold, (Al.) Ueber Calamiten und Steinkohlenbildung. Leipzig, 1841.

Presl, (K. Bos.) Beiträge zur kunde vorweltl. Pflanzen. (Verhandl. d. Gesellsch. d. Vaterl. Museum in Böhmen. 1837.)

Renault, (B.) Etudes sur quelques végétaux silicifiés des environs d'Autun. (Ann. Sc. nat., 5th ser., vol. xii.)

Recherches sur l'organisation des *Sphenophyllum* et des *Annularia*. (*Ibid.*, vol. xviii.)

Structure comparée de quelques tiges de la Flore Carbonifére. (Nouv. arch. du Museum de Paris, 11, 2d series. 1879.

Roehl. Fossile Flora der Steinkohlen formation Westphalens, ein-schlieslich Piesberg und Osnabrück. Cassel, 1868.

Roemer, (Fr. Ad.) Pflanzen des productiven Steinkohlengebirges am Harz und Piesberg. (Palæontograph. vol. ix.)

Sauveur, (J.) Végétaux fossiles des anciens terrains houillers de Belgique. Bruxelles, 1868. (No text.)

Schimper (W. P.) et Mougeot, (A.) Monographie des plantes fossiles du grès bigarré des Vosges, 4°. Leipsic, 1844.

Schimper, (W. P.) Les végétaux fossiles de Terrain de Transition des Vosges, (in Terrain de Transition des Vosges, by J. Kœchlin-Schlumberg & W. P. Schimper, 4°. Strasbourg, 1862.)

Traité de Paléontologie Végétale. Paris, 1874.

Schimper (W. P.) and Karl Zittle. Handbuch der Palæontologie. (1879.) Not finished.

Scheuchzer. Herbarium diluvianum. (1709.)

Schlotheim, (E. Freih. v.) Beschreibung merkwurdiger Kräuterabdrücke und Pflanzenversteinerungen. Gotha, 1804.

Flora der Vorwelt, 1 Abth. Gotha, 1804.

Die Petrefactenkunde auf ihrem, jetzigen Standpunkte. Gotha, 1820, mit Nachträgen. Abth. I & II, Gotha, 1822–1823.

Steinhauer, (H.) On Fossil Reliquia of unknown vegetables in Coal Strata. (Trans. Amer. Phil. Soc., 1.) 1818.

Sternberg, (Gasp. Graf. v.) Versuch einer Geognost. botan. Darstellung der Flora der Vorwelt, fol. liv. 1–4. Leipzig, 1821–1838.

Stur, (D.) Beiträge zur Kenntniss der Flora der Vorwelt, fol. Vol. I. Die Culm-Flora des märisch-Schlesischen Dachschiefers. Vien., 1875.

Vol. II. Die Culm-Flora der ostrauer und Walden burger Schichten. Vien., 1877.

Teschemacher, (J. E.) On the Fossil Vegetation of America. Boston Journ. Nat. Hist., vol. V, 1847.

Unger, (Fr.) Ueber die Structur der Calamiten und ihre Rangordnung im Gewächsreich. (Amtl. Bericht d. Versammel. d. Naturf. u. Aerzte zu Erlangen, 1840.)

Genera et Species plantarum fossilium. Vindob, 1840.

Synopsis plantarum fossilium. Leipzig, 1845.

Beiträge zur Palæontographie des Thuringes-Walde, 1856.

Vanuxem, (Lard.) Geology of New York. Albany, 1842.

Weiss, (C. E.) Fossile Flora der jungsten Steinkohlen formation, u. d. Rothliegenden in Saargebiet. Bonn, 1869–1872.

Studien uber Odontopteriden. (Zeitsch. Deutsch., Geol. Gesellsch, 1870.)

Williamson, (W. C.) On the structure of the woody zone of an undescribed form of *Calamites*. (Mem. of the Liter. and Phil. Soc., Manchester, 1869.)

On a new form of Calamitean Strobilus. (*Ibid.*, 1870.)

Notes on the organs, fructification, and foliage of *Calamodendron commune*. (*Ibid.*, 1870.)

On the organization of *Volkmannia Dawsoni*. (*Ibid.*, 1870–71.)

On the organization of the Fossil Plants of the Coal Measures. Part I–X, 4°. (Philos. Transact., 1871–1880.)

Witham, (H.) Observations on Fossil Vegetables, illust. of their internal structure. London, 1831.

Wood, (Horatio C.) Contributions to the Carboniferous Flora of the United States. (Proceed. Acad. Nat. Sci. of Philadelphia, 1860.)

Catalogue of carboniferous plants in Museum Acad. Nat. Sci. (*Ibid.*, 1860.

Contribution to the knowledge of the Flora of the Coal Period in the United States. (Proceed. Amer. Philos. Soc., vol. xiii, 1866.

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A. Index to Botanical Names.

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Page 3, top line, for Rhizomorphia, read Rhizomorpha.

Page 20, line 5 from bottom, for Hebr, read Helv.

Page 89, lines 13—18 from top, omit the whole period.

Page 96, line 3 from top, erase 852.

Page 99, line 7 from top, for leaflet of *Cyclopteris*, read cyclopterid leaflet.

Page 140. line 4 from bottom, for brardlei, read Bradleyi.

Page 145, line 10 from top, for Dictycophyllum, read Dictyophyllum.

Page 173, line 22 from top, for vinelets, read veins.

Page 197, line 7 from bottom, after Alethopteris nervosa, add Lesqx., Geol. of Penn'a, 1858.

Page 230, line 1 from top, for subconglomerate, etc., read Port Griffith, between F. and C. vein.

Page 261, line 24 from top, for of the Genus Spiropteris, read or the Genus Sphœropteris.

Page 263, line 6 from top, for intermediate the, read intermediate to the.

Page 269, line 11 from top, erase Boehsiana.

Page 303, add to the last line, Catskill Red Shale, Tioga county, Mr. M. A. Sherwood.

Page 310, line 19 from top, for Lepidophyllum, read Lepidoxylon.

Page 312, to the second paragraph, for Prof. Dawson, etc., substitute: Prof. Dawson remarks, on a specimen of this species, in the Cabinet of Prof. Wm. Rogers, that it very closely resembles a beautiful leaf from the Ponent of Pennsylvania, figured but not described, Geol. of Penn'a, 1858, Pl. XXII, and compared by Prof. Balfour to *Salisburia adiantoides*, a likeness, etc.

Page 330, line 13 from top, before Geol Rep., read *Staphylopteris Worthenii*.

Page 336, line 25 from top, for Newbury, read Newberry.

Page 352, line 15 from top, for Mr. Ed. Jones, read Mr. Williams.

Page 400, line 6 from bottom, for Bothodendron, read Bothrodendron.

Page 411, line 3 from bottom, for my figure, read my fig. 9. Atl., Pl. LXXIV.

Page 412, line 7 from top. for figured from, read figured Pl. LXXXVII, f. 1, this vol., from,

Page 428, line 4 from bottom, for the fragment Pl., read the fragment Atl. Pl.

Page 483, line 12 from bottom. for Worthen, read Worther.

Page 513, line 17 from top, for Uvularia. read *Utricularia*.

Page 518, line 22, after palmalifidus, add Atl.

Page 519, line 19. for one, read many.

Page 539, line 5, for Cardiocarpus, read Rhabdocarpus.

Page 573, line 6 from bottom. for II, read I.

Page 637, add to bottom of page: Sign — indicates that the species is present at all the localities of the column. ° Indicates uncertain geological distribution or locality.

Page 639, top, for Helansville, read St. Clairsville.

Errata in the explanation of the plates in Atlas.

Pl. III, for Fig. 1—5*a*, read 1—4.

Pl. III, for Fig. 6—7, read 5—7.

Pl. XXXVIII, for Uvularia, read Utricularia.

Pl. LXIX, Fig. 31, for Lepidophyllum spathulatum Sp. nov., read Lepidophyllum affine, Lx.

Pl. LXXII, f. 7, 8, for S. attenuata, read S. Lescurii, Schp.

Pl. LXXII. f 9, for S. Lescurii, Schp., read S. attenuata, Lx.

Pl. LXXIII, f. 7, for S. Menardi, Bt., read S. ichthyolepsis, St.

Pl. LXXV, f. 16, for Bornia approximata Sp. nov., read Calamodendron species.

Pl. LXXXIII, read f. 6, 6*a*. Cordiacarpus apiculatus, Sp. nov., f. 7, C. ovalis, Sp. nov.

Pl. LXXXV, f. 52, for Carpolithes rostellatus, Lx., read Rhabdocarpus arcuatus, Lx.